PB82-109323

Fish Resources and Aquatic Habitat Impact Assessment Methodology for the Ohio River Basin Energy Study Area

Ohio River Basin Energy Study
Urbana, IL

Prepared for

Environmental Protection Agency
Washington, DC

Sep 81

U.S. Department of Commerce
National Technical Information Service

TYPING GUIDE SHEET
BEGIN FIRST LINE OF TEXT HERE
CENTER OF PAGE
TOP OF IMAGE AREA
DROPPED HEAD; BEGIN SECTIONS HERE

September 1981
EPA-600/7-81-052

PB82-109323

FISH RESOURCES AND AQUATIC HABITAT IMPACT ASSESSMENT METHODOLOGY FOR THE OHIO RIVER BASIN ENERGY STUDY AREA

by

Clara Leuthart
Hugh T. Spencer

Prepared for
Ohio River Basin Energy Study (ORBES)

Grant Number EPA R804816

Project Officer

Lowell Smith
Office of Environmental Engineering and Technology
Office of Research and Development
U.S. Environmental Protection Agency
Washington, D.C. 20460

REPRODUCED BY
NATIONAL TECHNICAL INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

6-1/2"
9-1/8"
BEGIN LAST LINE OF TEXT
3/8"
BOTTOM OF IMAGE AREA; OUTSIDE DIMENSION FOR TABLES AND ILLUSTRATIONS
PAGE NUMBER
EPA-287 (Cin.)
(4-76)

012

EPA-600/7-[illegible]-052

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.
EPA-600/7-81-052

2.

3. RECIPIENT'S ACCESSION NO.
PB92 109323

4. TITLE AND SUBTITLE
Fish Resources and Aquatic Habitat Impact Assessment Methodology for the Ohio River Basin Energy Study Area

5. REPORT DATE
June 1980

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)
Clara Leuthart
Hugh T. Spencer

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
University of Louisville
Louisville, Kentucky 40218

10. PROGRAM ELEMENT NO.
C2JN1E

11. CONTRACT/GRANT NO.
R804816

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. Environmental Protection Agency
Office of Research and Development
Office of Environmental Engineering and Technology
Washington, D.C. 20460

13. TYPE OF REPORT AND PERIOD COVERED

14. SPONSORING AGENCY CODE
EPA-ORD

15. SUPPLEMENTARY NOTES
This project is part of the EPA-planned and coordinated Federal Interagency Energy/Environment Research and Development Program

16. ABSTRACT

This report was prepared as part of the Ohio River Basin Energy Study (ORBES), a multidisciplinary policy research program supported by the Environmental Protection Agency. Its purpose is to provide information on the fish resources, water quality, and aquatic ecology of the Ohio River Basin. This information is used as background for the assessment of water-related impacts under a number of energy development scenarios.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Energy Conversion Environments	Integrated Assessment Coal Nuclear	

18. DISTRIBUTION STATEMENT
Release to public

19. SECURITY CLASS (This Report)
unclassified

20. SECURITY CLASS (This page)
unclassified

21. NO. OF PAGES
458

22. PRICE
456

EPA Form 2220-1 (9-73)

DISCLAIMER

This report has been reviewed by the Office of Research and Development, U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

The Ohio River Basin Energy Study (ORBES) is an interdisciplinary, multi-university inquiry into the environmental, economic, and social impacts of energy facility development in a major portion of the Ohio River Basin. The study was initiated by the U.S. Environmental Protection Agency in 1976 in response to a directive from the U.S. Senate Appropriations Committee.

Most of the ORBES research was conducted by a group of faculty members at the University of Illinois, Indiana University, the University of Kentucky, the University of Louisville, The Ohio State University, the University of Pittsburgh, Purdue University, and West Virginia University. In a few instances, the necessary expertise was found at other universities or independent research organizations.

This report is one of a series produced in support of the overall ORBES assessment. For a summary of the entire study, see Ohio River Basin Energy Study (ORBES): Main Report, by the ORBES Core Team, also being published by the U.S. Environmental Protection Agency.

TABLE OF CONTENTS

Page

Foreword iii

List of Tables vi

List of Figures ix

List of Appendices xi

Chapter

1.0 AQUATIC SETTING OF THE ORBES REGION 1

1.1 Navigable waterways flow and water quality 9
1.2 Tributary flow and water quality 13
1.3 Lake systems and water quality 14
1.4 Slough and wetland water quality 15
1.5 Existing regional water quality impacts 16

2.0 CLASSIFICATION AND DISTRIBUTION OF FISHES OF THE ORBES REGION 32

2.1 Historical data and fish surveys 32
2.2 Categorization of fishes in the ORBES region 39

3.0 FISH HABITATS AND AQUATIC ECOLOGY 46

3.1 The aquatic biota of the ORBES region 49
3.2 Navigable waterway ecosystems 69
3.3 Tributary ecosystems 78
3.4 Lake ecosystems 79
3.5 Slough and wetland ecosystems 81
3.6 Existing regional aquatic ecosystem impacts 82

4.0 WATER IMPACTS FOR OHIO RIVER BASIN ENERGY STUDY SCENARIOS 92

4.1 Water quality impact overview 97
4.2 Aquatic ecology impacts overview 105
4.3 Once-through cooling on the Ohio main stem 122

5.0 THE EFFECTS OF CHANGES IN WATER QUALITY ON FISH DISTRIBUTION 130

5.1 Effects of non-conservative elements on fish distribution 130
5.2 Effect of conservative elements on fish distribution 151
5.3 Entrainment and impingement 152

Preceding page blank

LIST OF TABLES

		Page
TABLE 1-1	STREAMS AND TRIBUTARIES MODELED FOR BASELINE AND SCENARIO IMPACT ANALYSIS	19
TABLE 1-2	PERIODS OF EXCEPTIONAL LOW FLOW AT THE MCALPINE DAM	21
TABLE 1-3	WATER QUALITY REFERENCE STANDARDS USED IN THE ORBES STUDY TO COMPARE INCREMENTS IN AMBIENT CONCENTRATIONS OF CONSTITUENTS	25
TABLE 1-4	REACHES OF ORBES STREAMS IN VIOLATION OF STANDARDS DUE TO EXISTING BACKGROUND CONCENTRATIONS	28
TABLE 2-1	LOCK CHAMBERS AND MILE POINT OF COLLECTION SITES	35
TABLE 2-2	CATEGORIES OF FISH WITH RESPECTIVE FISH TYPE	33
TABLE 2-3	FISH BIOMASS PER COLLECTION YEAR	37
TABLE 2-4	DISTRIBUTION OF FISH SPECIES AMONG SEVENTY RIVERS IN THE ORBES REGION	40
TABLE 2-5	FISH FOUND IN ONLY ONE ORBES RIVER OR STUDY REGION	41
TABLE 2-6	UBIQUITOUS FISH SPECIES OF THE ORBES REGION	44
TABLE 3-1	ENDANGERED MOLLUSCS OF THE ORBES REGION	58
TABLE 3-2	CLASSIFICATION AND PROTECTION LEVELS FOR ORBES WATERWAYS	62
TABLE 3-3	FISH CHOSEN BY U.S. EPA AS EXAMPLE SPECIES FOR THE DEVELOPMENT OF TEMPERATURE CRITERIA FOR THE OHIO RIVER	72

LIST OF TABLES (Continued)

Page

TABLE 3-4 RECOMMENDED TEMPERATURE CRITERIA FOR THE OHIO RIVER MAIN STEM 76

TABLE 3-5 EXISTING CONDITION AND PROTECTION LEVELS OF SELECT ORBES STREAMS 84

TABLE 3-6 SUMMARY OF PROJECTED IMPACT OF A PROLONGED DROUGHT ON SELECT ORBES STREAMS AND RIVERS UNDER EXISTING CONDITIONS 86

TABLE 4-1 OHIO RIVER BASIN ENERGY STUDY SCENARIOS BASIC DESCRIPTION OF SCENARIOS 93

TABLE 4-2 SUMMARY OF WATER QUALITY AND CONSUMPTION IMPACT EVENTS 100

TABLE 4-3 PROPORTION OF WATER QUALITY EVENTS DUE TO WATER CONSUMPTION 101

TABLE 4-4 SCENARIO RICHNESS FOR WATER QUALITY AND WATER CONSUMPTION EFFECTS 103

TABLE 4-5 SEVEN DAY TEN YEAR LOW FLOW IMPACT FOR 1976 110

TABLE 4-6 BASE CASE COMPARED TO 1976 111

TABLE 4-7 STRICT CONTROLS COMPARED TO 1976 112

TABLE 4-8 STRICT CONTROLS COMPARED TO BASE CASE 113

TABLE 4-9 BASE CASE COMPARED TO COAL-FIRED EXPORTS 114

TABLE 4-10 BASE CASE COMPARED TO NUCLEAR FUEL EXPORTS 115

TABLE 4-11 BASE CASE COMPARED TO NUCLEAR EMPHASIS 116

TABLE 4-12 BASE CASE COMPARED TO ALTERNATIVE FUEL EMPHASIS 117

TABLE 4-13 BASE CASE COMPARED TO NATURAL GAS EMPHASIS 118

TABLE 4-14 BASE CASE COMPARED TO COAL EMPHASIS, LOW ECONOMIC GROWTH 119

LIST OF TABLES (Continued)

Page

TABLE 4-15 BASE CASE COMPARED TO HIGH ECONOMIC GROWTH, LOW ENERGY GROWTH 120

TABLE 4-16 BASE CASE COMPARED TO HIGH ECONOMIC GROWTH, AND HIGH ELECTRICAL ENERGY GROWTH 121

TABLE 5-1 PROVISIONAL MAXIMUM TEMPERATURES RECOMMENDED AS COMPATIBLE WITH THE WELL BEING OF VARIOUS SPECIES OF FISH AND THEIR ASSOCIATED BIOTA 135

TABLE 5-2 TEMPERATURE PARAMETERS FOR FISHES IN THE ORBES REGION 139

TABLE 5-3 THRESHOLD LEVELS OF pH FOR FISH OCCURRENCE 149

TABLE 5-4 WATER QUALITY STANDARDS AND LEVELS OF FISH TOLERANCE 153

TABLE 5-5 FISHES POTENTIALLY IMPACTED AT THE WATER INTAKE 157

TABLE 5-6 RIVER BANK USES BY FISHES 161

LIST OF FIGURES

		Page
Figure 1-1	The Ohio River Basin Energy Study region	2
Figure 1-2	ORBES streams and tributaries	3
Figure 1-3	Coal fields of the ORBES region	10
Figure 1-4	ORBES region navigable waterways	11
Figure 1-5	Areas having major sloughs and wetlands in the ORBES region	17
Figure 1-6	Temperature and dissolved oxygen profiles for the 1977 Ohio River main stem base case	30
Figure 3-1	Distribution of the carp in Illinois	47
Figure 3-2	Distribution of the pallid shiner in Illinois	48
Figure 3-3	Distribution of the river shiner in Illinois	50
Figure 3-4	Distribution of the northern brook lamprey in Illinois	51
Figure 3-5	Distribution of the mountain madtom in Illinois	52
Figure 3-6	Distribution of the bigmouth shiner in Illinois	53
Figure 3-7	Distribution of the blackspotted topminnow in Illinois	54
Figure 3-8	Distribution of the horneyhead chub in Illinois	55
Figure 3-9	ORBES streams having endangered fishes	56
Figure 3-10	Expectation function for regional indices	67

LIST OF FIGURES (Continued)

		Page
Figure 3-11	Ubiquitous species as a function of of species total number	68
Figure 3-12	Protection levels of ORBES streams	70
Figure 4-1	Information flow for scenario impact analysis	98
Figure 5-1	Nomograph to determine the maximum weekly average temperature of plumes for various ambient temperatures, °C °F	140
Figure 5-2	Nomograph to determine the acceptable seasonal minimum oxygen concentration (Mg/l)	147

List of Appendices

Appendix A Systematic Listing of the Fishes of the ORBES Region
Appendix B Alphabetical Listing of the Fishes of the ORBES Region
Appendix C Distribution of FIsh Species in the ORBES Region
Appendix D Habitat Requirements of Fish Species of the ORBES Region
Appendix E Summary Tables of Incremental Water Quality and Water Consumption Scenario Impacts
Appendix F Summary Tables of Sum Total Water Quality and Water Consumption Scenario Impacts Used in Aquatic Habitat Impact Assessments

Chapter 1.0 Aquatic Setting of the ORBES Region

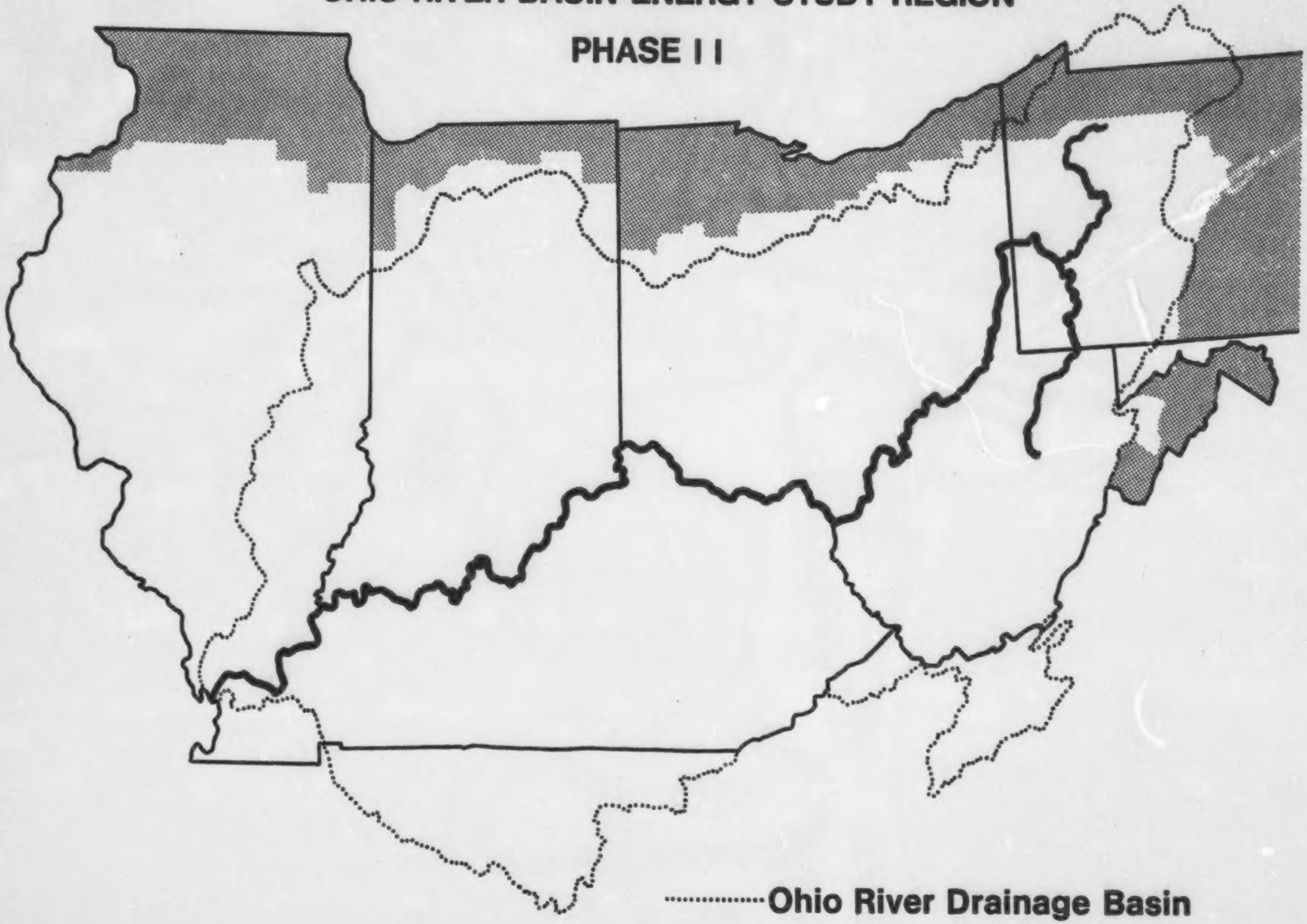
This report of the fish resources, water quality and aquatic ecology in the Ohio River Basin, is presented as a baseline document for the analysis of impacts from power generating facilities within the Ohio River Basin Energy Study (ORBES) region (Figure 1-1). The report is based on existing information; new field measurements and collections were excluded from the study. The major emphasis in this report is on fish resources and the impact methodology appropriate thereto. The literature resources are more complete for the distribution, physiological and ecological requirements and effects of power generating facilities of fish populations in the ORBES region than for most other organisms.

The ORBES region encompasses most of the drainage area of the Ohio River Basin, includes the Mississippi River Basin where it borders the states of Illinois and Kentucky, and also takes in the southern periphery of some Great Lakes drainage (see Figure 1-2). Subsequently, the region has as diverse an inland aquatic setting as can be found in the United States. This area includes whitewater canoe and mountain trout streams, deep clear lakes popular as SCUBA diving sites, major rivers both navigable and free flowing, and numerous wetlands and sloughs found both in mountain valleys in the east and along the major river basins in the west. Next to the Nile, the oldest

Figure 1-1.

OHIO RIVER BASIN ENERGY STUDY REGION

PHASE I I



··········Ohio River Drainage Basin

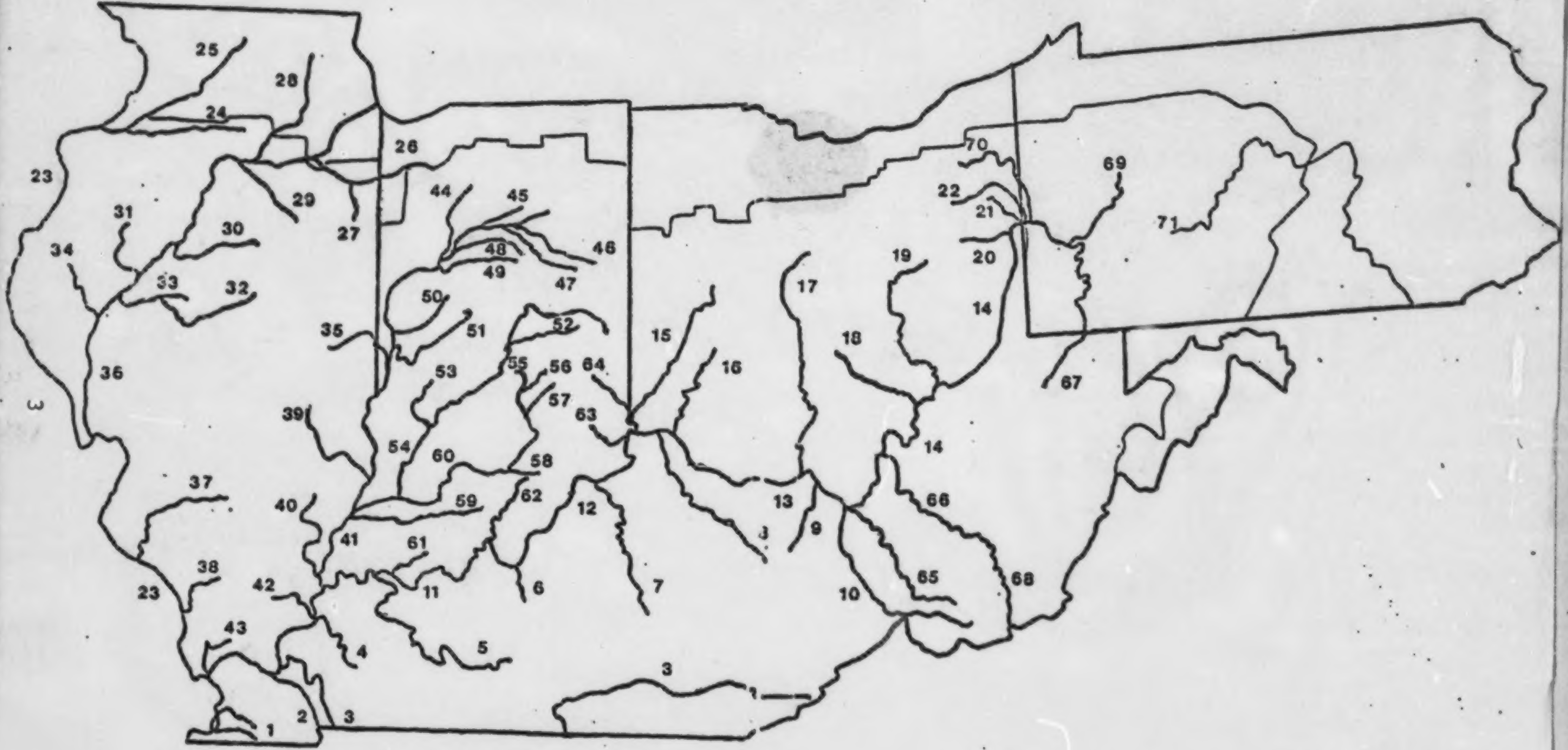

25
28
24
26
23
31
29
30
27
44
45
34
33
32
48
49
46
47
50
51
52
35
36
53
55
56
64
57
63
39
54
60
58
59
62
12
37
40
41
61
11
6
7
38
42
23
43
4
5
1
2
3
3
15
16
17
13
8
9
10
18
19
14
14
20
21
22
70
69
71
66
65
68
67

Figure 1-2 ORBES streams and tributaries.

Legend for Figure 1-2

Map Number		Stream,or River
Kentucky	1	Bayou de Chien and Obion Creek
	2	Tennessee River
	3	Cumberland River
	4	Tradewater River
	5	Green River
	6	Salt River
	7	Kentucky River
	8	Licking River
	9	Little Sandy River
	10	Big Sandy River
	11	Ohio River from the Salt River to the Mississippi
	12	Ohio River from the Port of Cincinnati, OH to the Salt River
	13	Ohio River from the Big Sandy River to the Port of Cincinnati
	14	Ohio River from Pittsburgh, PA to the Big Sandy River
Ohio	15	Great Miami River
	16	Little Miami River
	17	Scioto River
	18	Hocking River
	19	Muskinghum River
	20	Big Yellow Creek
	21	Little Beaver Creek
	22	Mahonig River

Legend for Figure 1-2

Map Number	Stream, or River
Illinois 23	Mississippi River
24	Green River
25	Rock River
26	Kankakee River
27	Iroquois River
28	Fox River
29	Vermilion River (I)
30	Mackinaw River
31	Spoon River
32	Sangamon River
33	Salt River
34	La Moine River
35	Vermilion River (II)
36	Illinois River
37	Kaskaskia River
38	Big Muddy River
39	Embarras River
40	Little Wabash River
41	Wabash River
42	Saline River
43	Cache River
44	Tippecanoe River
45	Eel River (I)
46	Salamonie River

Legend for Figure 1-2 (Continued)

Map Number		Stream, or River
Indiana	47	Mississinewa River
	48	Deer Creek
	49	Wildcat Creek
	50	Sugar Creek (I)
	51	Raccoon Creek
	52	Fall Creek
	53	Eel River (II)
	54	West Fork of the White River
	55	Sugar Creek (II)
	56	Big Blue River (I)
	57	Flat Rock Creek
	58	Muscatatuck River
	59	Patoka River
	60	East Fork of the White River
	61	Little Pigeon Creek
	62	Big Blue River (II)
	63	Laughery Creek
	64	Whitewater River
West Virginia	65	Guyandotte River
	66	Kanawha River
	67	Monongahela River
	68	New River
Pennsylvania	69	Allegheny River

Legend for Figure 1-2 (continued)

Map Number	Stream, or River
Pennsylvania	
70	Beaver River
71	Susquehana River

drainage system in the world is found here in the Kanawha and New River valleys which, as one might expect, hold an almost unique fauna. The New River and some of its tributaries are among the most popular canoe and raft streams in the eastern United States.

The major navigable artery of the ORBES region is the Ohio River mainstem. This river flows 981 miles in a southwesterly direction from its point of origin at the confluence of the Allegheny and Monongahela at Pittsburgh, Pennsylvania to its termination at the Mississippi at Cairo, Illinois. Navigation on the Ohio was first made possible by the construction of 48 low-lift or navigable-pass dams. This system was completed in the early 1930's and remained in operation without further change for 35 years. Then, beginning in 1965, the construction of 19 high-lift dams was undertaken. The high-lift dam system is essentially in place today and has, for all intent and purposes, opened up the entire Midwest as a port on the Gulf of Mexico. This event has had a great deal to do with industrial development in the Midwest, and subsequently with origins of the ORBES study.

The geology of the ORBES region as it affects land use, water quality and aquatic habitats is also diverse. The northern portions of Illinois, Indiana, and Ohio, and to some extent western Pennsylvania, are generally designated as prime agricultural land with corn, wheat and soybeans being major crops. This part of the region, which was under glacial ice as recently as 10,000 years ago, was completely timbered by 1900. The streams in this area have thus been somewhat altered from their original setting, although some of the smaller tributaries do remain in a near native state.

The Eastern Interior Basin underlies most of Illinois and southern Indiana, and extends into western Kentucky (see Figure 1-3). To the east, the Appalachian Basin forms somewhat of an eastern boundary for the ORBES region. Both basins contain abundant coal reserves and are actively mined by all available techniques. Mining and the impacts of successive years of poor logging and farming practice had also taken their toll on the southern and eastern portion of the ORBES region by 1900. Still, many ecologically valuable streams and wetlands remain here much the same as before the region was settled.

1.1 Navigable waterways' flow and water quality

Ten rivers in the ORBES region in addition to the Ohio have been made navigable by the construction of locks and dams. These waterways are shown in Figure 1-4 and drain virtually 100 percent of the ORBES area; the Wabash is the only major river in the region which is not navigable.

The navigable waterways draining to the Ohio River carry a predominance of industrial and organic pollutants;

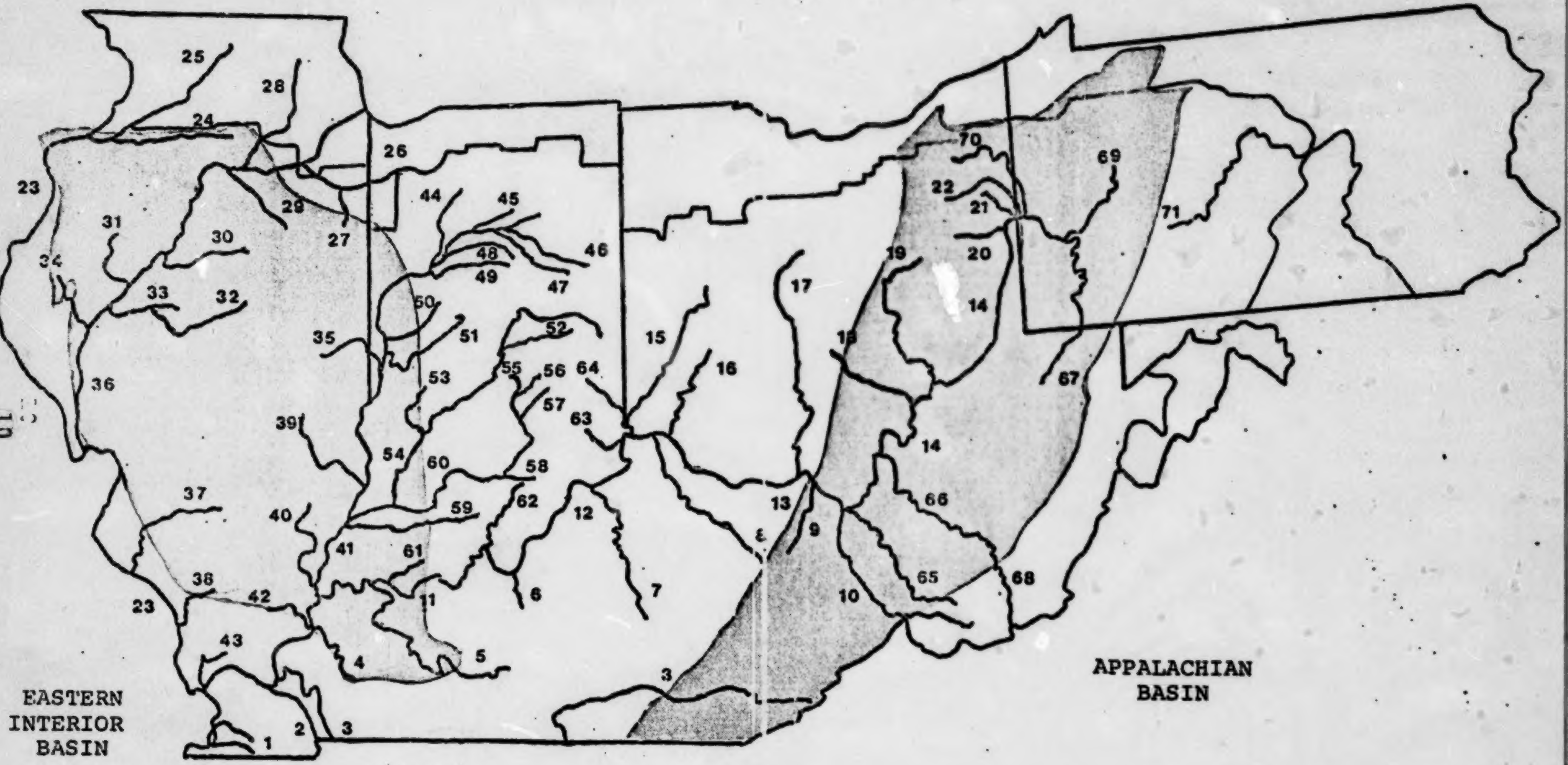

25
28
24
23
26
44
45
29
27
31
30
46
34
48
49
47
33
32
50
35
51
52
53
55
56
64
57
63
36
39
54
60
58
37
40
59
62
41
61
11
38
42
23
43
4
5
1
2
3
15
16
17
13
8
12
7
6
3
9
10
19
18
14
14
66
65
70
22
21
20
69
71
67
68
EASTERN
INTERIOR
BASIN
APPALACHIAN
BASIN

Figure 1-3 Coal-fields of the ORBES region.

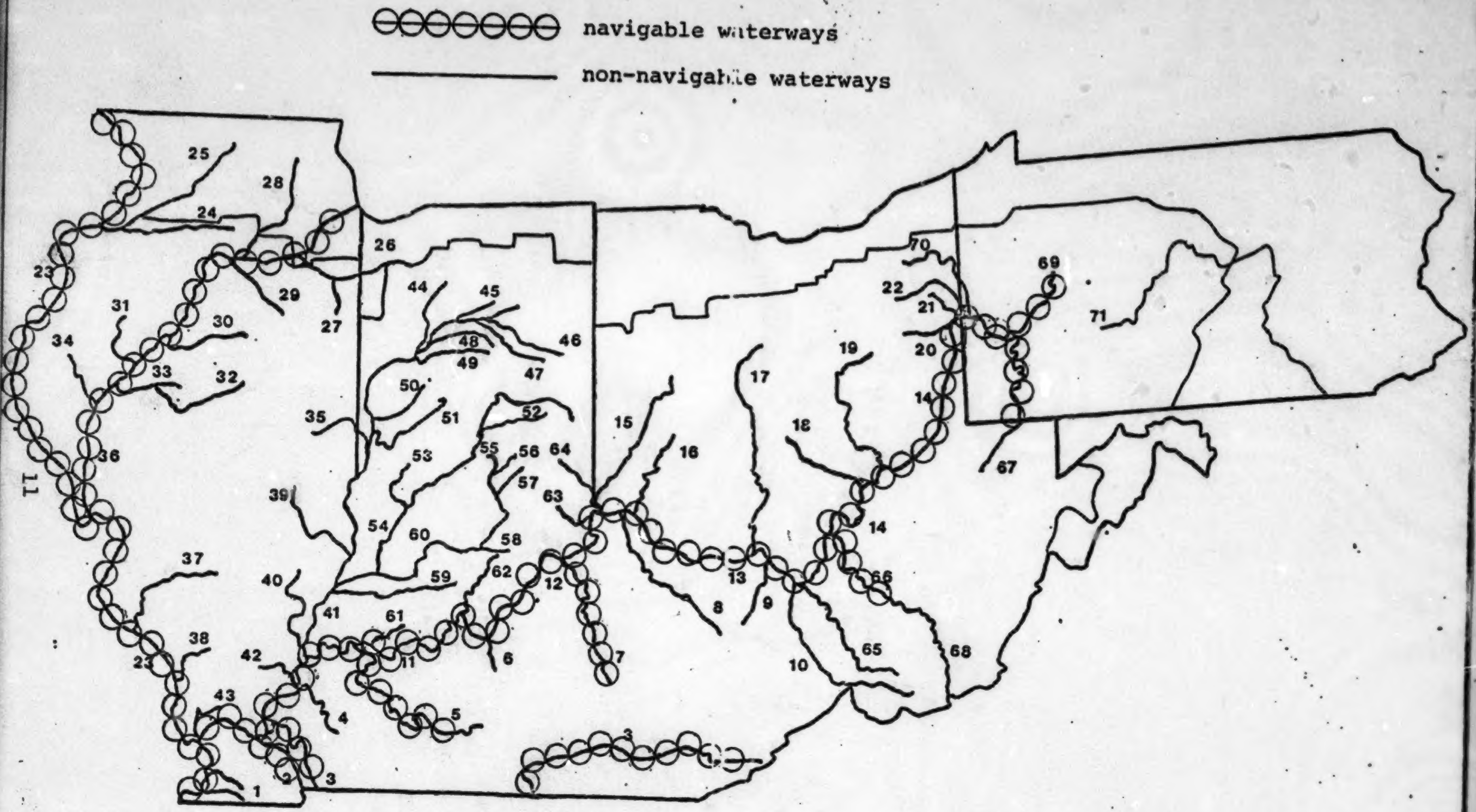

navigable waterways
non-navigable waterways
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71

Figure 1-4 ORBES region navigable waterways.

those streams going to the Mississippi carry primarily pollutants from agriculture. In both areas, problems develop in late summer at seasonal low flow. Under these conditions, dissolved oxygen levels drop, in some instances to near zero, and algal blooms begin to appear. In addition, late summer water temperatures exceeding 30°C (86°F) are common in the navigable pools. However, water quality in the navigable pools improves considerably with winter and spring flows.

In late summer the larger navigable pools in the region, particularly on the lower Ohio, become long narrow lakes. These systems show poor mixing of effluents which instead, tend to follow along the banks below their points of entry. Some mixing does occur in the barge channels as a result of propeller action and bow wakes. Also, wind waves and biological reaeration due to photosynthesis add to dissolved oxygen levels with the effects of photosynthesis becoming more pronounced as the pools clarify.

Impoundments throughout the region now store adequate water to maintain flow needed for the purpose of navigation. The operation of these impoundments, and of the lock and dam systems themselves, to help maintain dissolved oxygen levels at or above 5 mg/l also appears possible, and is a subject currently under study by the U.S. Army Corps of Engineers (1). Low-lift dam systems which pass water over a spillway like any waterfall are a direct benefit to the cause of maintaining dissolved oxygen levels. High-lift dam systems such as those on the Ohio River pass water from beneath the dam but are a source of significant reaeration, nonetheless.

The ecological systems along the banks of the navigable waterways are especially important. Consequently, the maintenance of water quality in backwater areas along these banks and at points of tributary confluence is essential. At present, the region's navigable waterways, in addition to being major transportation arteries, serve also as abundant biological and recreational resources, and as water supplies for millions of residents (2).

1.2 Tributary flow and water quality

Tributaries of the navigable rivers in the ORBES region vary in size from ephemeral streams to large rivers and provide a variety of aquatic habitats. Streams and rivers in the eastern portion of the region are of higher gradient than those to the west. The eastern streams include those of the Appalachian Mountains in West Virginia, Pennsylvania, and Kentucky. Glaciated areas to the north of the Ohio River in Indiana, Illinois, and Ohio contain, in turn, an extensive flat terrain. Streams in this locale have flow characteristics and aquatic life forms somewhat different from those to the south and east.

Where the Ohio River joins the Mississippi, a third environmental setting is formed. Velocity is greatly reduced in this area of low-gradient streams, and slow-flowing pools are more numerous.

In general, tributary headwaters are of better quality than lower reaches, except in areas where mining has been intense. Orphaned mined land in Appalachia and in the Eastern Interior Basin predominate as the problem source for many of the region's tributaries. Other tributaries receive substantial quantities of organic waste. As noted earlier in this section, numerous small tributaries of flowing streams exist in the ORBES region today much as they always have. They may be found in isolated areas of the region's state and national parks. A few of these small streams have watersheds protected from development, but are threatened,nonetheless, by the sulfate deposition (acid rain) problem now prevalent throughout the region.

1.3 Lake systems water quality

The abundant supply of water in the ORBES region is not limited to the area's streams and rivers. Numerous lakes, both natural and man-made, exist throughout the region providing a further source of diverse aquatic habitat. As noted in section 1.1, the construction of high-lift locks and dams on the Ohio mainstem has created a series of long, flowing pools whose characteristics combine those of rivers and lakes. Because the pools have been created on a navigable waterway, they are often referred to as flowing impoundments. Navigable pools along the Ohio do not store water in the sense of a true lake but let pass all water reaching each dam.

The two largest lakes in the ORBES region are found within a few miles of each other in western Kentucky. These are Kentucky Lake and Lake Barkley (see Figure 1-2, map numbers 2 and 3, respectively) which bound the famous wildlife refuge and recreational area known as the Land Between the Lakes.

Abundance of rainfall in combination with poor farming, foresting, and mining practices have also helped create a number of accidental lakes in the region. These range from small mine pits and ditches to 10,000-acre acid mine drainage swamps. Most of the swamps are located in western Kentucky; today they are being turned into protected wildlife habitats.

1.4 Slough and wetland water quality

The wetland resources of the ORBES region in western Kentucky and southern Illinois provide an extensive and productive wildlife habitat. Wetlands are described more specifically as marshes (wet or inundated grasslands), swamps (wet or inundated forests), or sloughs (areas inundated only partially). These areas are characterized by sluggish or stagnant water. Bottom sediments are soft and contain an abundance of organic material. Aquatic life is both abundant and diverse.

Sloughs, swamps, and marshes are extensive where the Ohio joins the Mississippi in western Kentucky and southern Illinois. The low gradient of streams and extensive spring and winter flooding contribute to the maintenance of these areas. Wetland areas in Illinois are the Cache and Saline drainage basins. Wetland areas in Kentucky include the Bayou de Chien and Obion Creek in the Jackson Purchase; such areas extend as far west as the Tradewater River. Specific examples include the Henderson Sloughs of Kentucky and Hovey Lake area of Indiana. Both are noted for their abundance of wildlife (see Figure 1-5).

Fortunately, the region's major sloughs and wetlands are in areas where severe water quality problems are absent. The major sloughs in western Kentucky are fed by the lower Ohio River, which is relatively well oxygenated by the time it reaches that area. Other sloughs and wetlands in the region are in watersheds where development other than farming is limited. For the time ,these systems are stable with water quality reflecting that of the source stream.

1.5 Existing regional water quality impacts

The people of the Ohio River Basin, and of the ORBES region in general, have not had to endure a true drought since the spring and summer of 1930, or since the "dustbowl thirties" as that time is popularly known. Such drought periods will recur, however, and one requirement of the

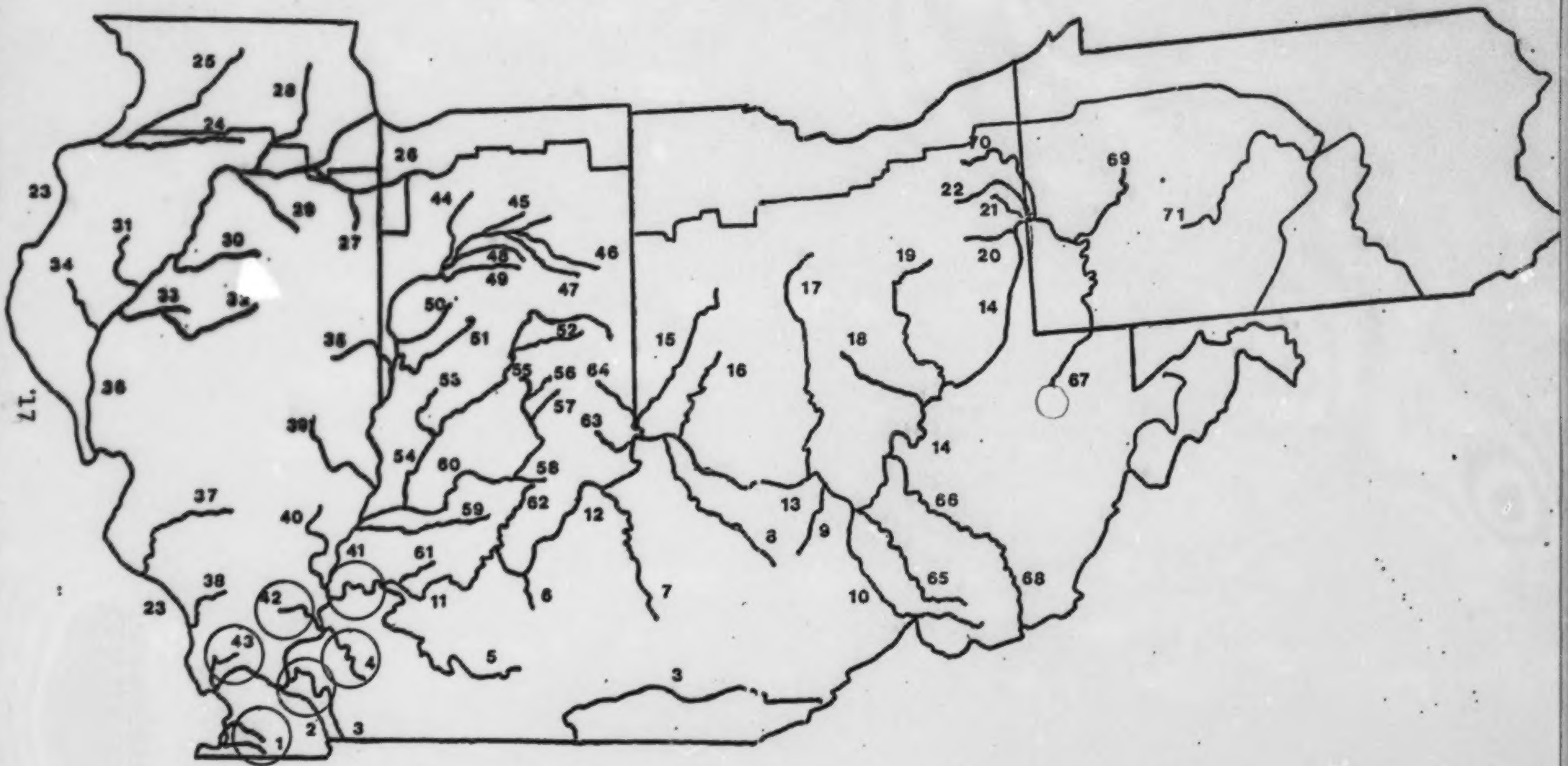

25
28
24
26
23
31
30
29
27
44
45
46
48
49
47
34
33
32
50
51
52
35
36
53
55
56
64
57
63
39
54
60
58
37
40
59
62
12
41
61
38
42
11
6
7
23
43
4
5
3
2
3
1
15
16
17
19
20
22
21
70
69
71
14
18
67
14
13
9
8
66
65
10
68

Figure 1-5 Areas having major sloughs and wetlands in the ORBES region.

ORBES project has been to estimate what their impact(s) will be through the year 2000 AD on a per scenario basis. The 1977 baseline case for this would be extended drought under existing conditions of water consumption and loading. The approach chosen for evaluation of this base case has been to estimate through computer modeling, some of the impacts on water quality which would occur if 7-day-10-year low flow were to simultaneously hit each stream system in the region. The models used were CORT[1], STREAM[2], and COLHEAT[3]. The streams modeled are listed in Table 1-1.

Periods of exceptional low flow at Ohio River mile point 606.8 (McAlpine Locks and Dam) are listed in Table 1-2. This point is 106 miles downstream from the midway point between Pittsburgh, Pennsylvania, and Cairo, Illinois, and it is close to the geographic center of the ORBES region.

---

[1] CORT is a water mass-balance model developed for the ORBES region through a special study granted to the Department of Civil Engineering, University of Illinois, Urbana, Illinois. Flows generated by CORT were used in estimating concentrations of conservative agents under conditions of low flow. CORT flows for the Ohio River were also used for STREAM and COLHEAT runs of the main stem.

[2] STREAM is a model developed specifically for the Ohio River mainstem by the Ohio River Valley Water Sanitation COmmission (ORSANCO), 414 East Walnut Street, Cincinnati, Ohio 45202. All modeling work done with STREAM was done in ORSANCO's computer center in Cincinnati, Ohio.

[3] COLHEAT is a general model that can be applied to any river system. All modeling work done with COLHEAT was for the Ohio Rivser main stem and was done through The Program on Energy Research, Education and Public Service, the Ohio State Universtiy, 1712 Neil Avenue, Columbus, Ohio 43210.

TABLE 1-1

STREAMS AND TRIBUTARIES MODELED[1] FOR BASELINE AND SCENARIO IMPACT ANALYSIS

System	Figure 1-2 Map Number	Reaches[2]	Reach to Reach 7-Day-10 Year Low Flow, cfs
Illinois River	36	9	451 to 3601
Big Muddy River	38	1	37 to 37
Kaskaskia River	37	1	100 to 100
Rock River	25	1	1306 to 1306
Mississippi River	23	7	15,725 to 47,412
White River	54	6	155 to 685
Wabash River	41	10	130 to 2498
Big Sandy River	10	2	26 to 59
Licking River	8	1	10 to 10
Salt River	6	1	20 to 20
Cumberland River	3	3	8 to 4100
Green River	5	2	306 to 500
Kentucky River	7	3	113 to 164
Scioto River	17	4	48 to 337
Muskingum River	19	2	551 to 566
Whitewater River	64	1	82 to 82
Great Miami River	15	4	58 to 281
Little Miami River	16	1	27 to 27
Beaver River	70	2	86 to 232
Allegheny River	69	4	470 to 1098
Monongahela River	67	3	384 to 459
Susquehana River	71	1	136 to 136

TABLE 1-1 (continued)

STREAMS AND TRIBUTARIES MODELED[1] FOR BASELINE AND SCENARIO IMPACT ANALYSIS

System	Figure 1-2 Map Number	Reaches[2]	Reach to Reach 7-Day-10-Year Low Flow, cfs
Kanawha River	66	2	1106 to 1285
Ohio River[3]	11,12,13,14	32	6558 to 45,421

---

[1] For the purpose of baseline and scenario impact analysis, all of the region's navigable waterways and 15 of its non-navigable tributaries were modeled for water mass balance and for conservative agent concentrations. In addition to this, the Ohio Mainstem was modeled for dissolved oxygen, temperature, and biochemical oxygen demand using the models STREAM and COLHEAT.

[2] In general, each system was modeled completely with the smaller streams being set up as a single reach.

[3] The reach of the Mississippi River below its confluence with the Ohio is included in the study up to the Kentucky state line. The 7-day-10-year low flow at this point is 93,833 cfs.

TABLE 1-2

PERIODS OF EXCEPTIONAL LOW FLOW AT THE McALPINE DAM

	Months With Average Flow ≤ 15,000 cfs		
Year	Month	Monthly Average Discharge, cfs	Longest Set of Days Running Consecutively That Year With A Flow ≤ 15,000 cfs
1929	NONE	-----	---
1930[1]	July	8,035	143
	August	4,924	
	September	6,005	
	October	4,377	
	November	6,660	
	December	14,085	
1931[1]	NONE	-----	---
1932[1]	August	8,635	37
1933[1]	October	12,196	18
1934[1]	NONE	-----	---
1935[1]	NONE	-----	---
1936[1]	September	15,009	21
1937[1]	NONE	-----	---
1938[1]	October	12,925	31
1939[1]	September	8,590	38
	October	14,618	
1940[1]	October	12,925	23
1941[1]	NONE	-----	---
1942[1]	NONE	-----	---
1943[1]	September	12,790	32
	October		
1944[1]	August	13,443	21
1945	NONE	-----	---

TABLE 1-2 (continued)

PERIODS OF EXCEPTIONAL LOW FLOW AT THE McALPINE DAM

Year	Months With Average Flow $\leq$ 15,000 cfs Month	Monthly Average Discharge, cfs	Longest Set of Days Running Consecutively That Year With A Flow $\leq$ 15,000 cfs
1946	September	11,046	13
1947	NONE	-----	---
1948	NONE	-----	---
1949	NONE	-----	---
1950	NONE	-----	---
1951[1]	October	12,355	12
1952[1]	September	15,033	29
1953[1]	September October November	10,295 7,316 9,161	59
1954[1]	NONE	-----	---
1955	September	11,735	16
1956	NONE	-----	---
1957[1]	August	12,885	29
1958	NONE	-----	---
1959[1]	September	14,500	10
1960[1]	NONE	-----	---
1961	NONE	-----	---
1962[1]	NONE	-----	---
1963[1]	September October	12,077 8,206	50

TABLE 1-2 (Continued)

PERIODS OF EXCEPTIONAL LOW FLOW AT THE McALPINE DAM

Year	Months With Average Flow ≤ 15,000 cfs Month	Monthly Average Discharge, cfs	Longest Set of Days Running Consecutively That Year With A Flow ≤ 15,000 cfs
1964[1]	September	11,098	28
1965[1]	August	12,411	8
1966[1]	NONE	-----	---
1967	NONE	-----	---
1968	NONE	-----	---
1969	NONE	-----	---
1970	NONE	-----	---
1971	NONE	-----	---
1972	NONE	-----	---
1973			
1974			
1975			
1976			
1977			
1978			

[1] Years having a period of low flow (≤ 15,000 cfs) extending for 7 or more days.

Source: These data were compiled by H. T. Spencer from official U.S.G.S. records and reported, in part, in the Environmental Impact Statement for the Newburgh Lock and Dam: U.S. Army Corps of Engineers, Louisville District, Louisville, Kentucky.

Regional drought would clearly be registered here and some analysis of this station's historical record should provide the reader with at least some sense of perspective. Admittedly the almost continuous change in the Ohio's watershed during the period over which these data were collected makes absolute prediction of flow recurrence intervals for both high and low flows difficult. However, a general assessment is possible.

The 7-day-10-year low flow used for the McAlpine Dam in the ORBES study is 14, 789 cfs[1]; thus, a figure of 15,000 cfs was selected as a reasonable cut-off point for Table 1-2 It can be seen from this table that the most dramatic period of low flow did come in 1930 with a 143-day period at the McAlpine Dam with a flow of 15,000 cfs or less. In other words, low flows of the order predicted now to occur for only one 7-day period out of every 10 years persisted in the region for 143 days between July and December of 1930. Other periods of extended low flow have occurred since, the latest of significance being the 50-day stretch in 1963, and recurrence of such intervals is certain.

Table 1-3 lists reference numbers[2] used in the ORBES study to compare increments in ambient concentrations

---

[1] Estimates of 7-day-10-year low flows used in the ORBES study are based upon official U.S.G.S. and U.S. Army Corps of Engineers predictions (3).

[2] These reference numbers are based on current legal statutes but may not be exactly the same as state standards for a given river. Such requirements vary slightly from (continued p 27).

TABLE 1-3

WATER QUALITY REFERENCE STANDARDS USED IN THE ORBES STUDY TO COMPARE INCREMENTS IN AMBIENT CONCENTRATIONS OF CONSTITUENTS

Constituent		Reference Standard, mg/l
Temperature, °C[1]		ORSANCO Standard
Dissolved oxygen[1]		5.00
Total dissolved solids[2]	IN	750.00
Total dissolved solids	IL,KY,OH,PA,WV	500.00
Total suspended solids		50.00
Sulfate		250.00
Ammonia		1.10
Arsenic		0.05
Barium		1.00
Cadmium		0.01
Chloride		250.00
Chromium		0.01
Phosphorus		0.05
Selenium		0.01
Silver		0.005
Copper		0.06
Iron		0.30
Lead		0.05
Manganese		0.05
Nickle		0.05
Mercury (μg/l)		0.05
Zinc		0.205
Boron		1.00

[1] Temperature and dissolved oxygen effects were evaluated for the Ohio River Mainstem for existing conditions and year 2000 AD scenarios. The dissolved oxygen criteria of 5.0 mg/l is generally not debated, but the standards for temperature established in 1970 by ORSANCO for the Ohio continue to be questioned by ORSANCO's Power Industry Advisory Committee (4).

[2] It was found appropriate to treat Indiana differently from the other ORBES states for total dissolved solids. The reference standards for all other parameters are the same for all states.

of constituents for a 1977 base case drought, and for year 2000 AD ORBES scenarios (3). Water quality data for the streams listed in Table 1-1 were collected where available for low flow conditions in the recent record (past 2 to 5 years). This data is summarized in Table 1-4 in terms of reference standard violations due to existing background levels alone. Similar results are given in Figure 1-6 for temperature and dissolved oxygen levels on the Ohio iver main stem on a mile by mile basis. The Ohio River summary figure differs from the data listed in Table 1-4 in that it is the result of computer simulation of exceptional low flow using STREAM and known 1977 loadings for organic waste and thermal discharges. Travel time[1] on the Ohio main stem for its 981 mile length is estimated to be 192 days at 7-day-10-year low flow; or for a period of 49 days longer than the driest spell on record (see Table 1-2). Computer simulation is, thus, the only means available for assessing the existing condition of the present Ohio River under the stress of such exceptional drought.

(cont.) state to state, and from state to federal standards. The Ohio River Valley Water Sanitation Commission (ORSANCO) currently has in force a Criteria Conflicts Committee charged with helping resolve differences between states involving water quality standards.

[1] The time required for a parcel of water to travel from point A to B at a given flow.

TABLE 1-4

REACHES[1] OF ORBES STREAMS IN VIOLATION OF STANDARDS DUE TO EXISTING BACKGROUND CONCENTRATIONS[2,3]

Constituent	Reference STD mg/1	36	38	37	25	23	54	41	10	6	3	5	11	17	15	16	70	69	67	71	66	11-14	64	8	19
		9	1	1	1	7	6	10	2	1	3	2	3	4	4	1	2	4	4	1	2	32	1	1	2
TDS	500				*					*			*							*					
SUS	50	*[2]	*	*	*	*	3	3	2	*		2	*	2	2	1				*		20	1	1	2
SO_4	250				*					*			*							*			*		
NH_3	1.10	2			*		1			*			*	1			1			*					
As	0.05			*	*		*	*		*			*					2		*			*		
Ba	1.00			*	*			*		*			*							*			*		
Cd	0.01			*	*					*	3		*		1	1				*		4	*		1
Cl	250				*					*			*							*			*		
Cr	0.01			*	*			*	2	*		2	*	4	3	1	1	1	1	*	1	32	*	1	2
P	0.05	9	1	1	*	7	6	10	2	*	3	2	*	4	4	1	4	4	3	*	1	32	1	1	2
Se	0.01			*	*		*	*		*			*	1						*			*	1	
Ag	0.005			*	*		*	*		*	3	2	*	3	3		1			*		14	*		1
Cu	0.06	2			*	2	1	4	2	*			*		1	1	1			*		14	*	1	
Fe	0.30	8	1	1	*	3	6	4	2	*	3	2	*	4	3	1	2	4	3	*	2	32	*	1	2
Pb	0.05	1			*				2	*		2	*	1	2	1		4		*	1	24	*		1
Mn	0.05	9	1	1	*	7	6	*	2	*	3	2	*	4	3	1	2	4	3	*	2	32	*	1	2
Hg(ug/1)	0.05	6		*	*	4	6	4	2	*	3	2	*	4	3	1	2	4	1	*	2	32	*	1	2
Ni	0.05				*			10	2	*			*						2	*			*		
Zn	0.205				*			*		*			*		2		1			*	1	14	*		
B	1.00				*		*	*	2	*	*	*	*	*	*	*	*	*	*	*	*	*	*		

---

[1] For an explanation of map numbers and reach, see Figure 1-2 and Table 1-1, respectively.

[2] Streams and/or parameters for which recent (past 2 to 5 years) low flow records are not available are marked with the symbol ******.

[3] Blank spaces indicate zero reaches in violation.

The following conclusions concerning existing regional conditions can be drawn from the data in Table 1-4 and the simulation shown in Figure 1-6.

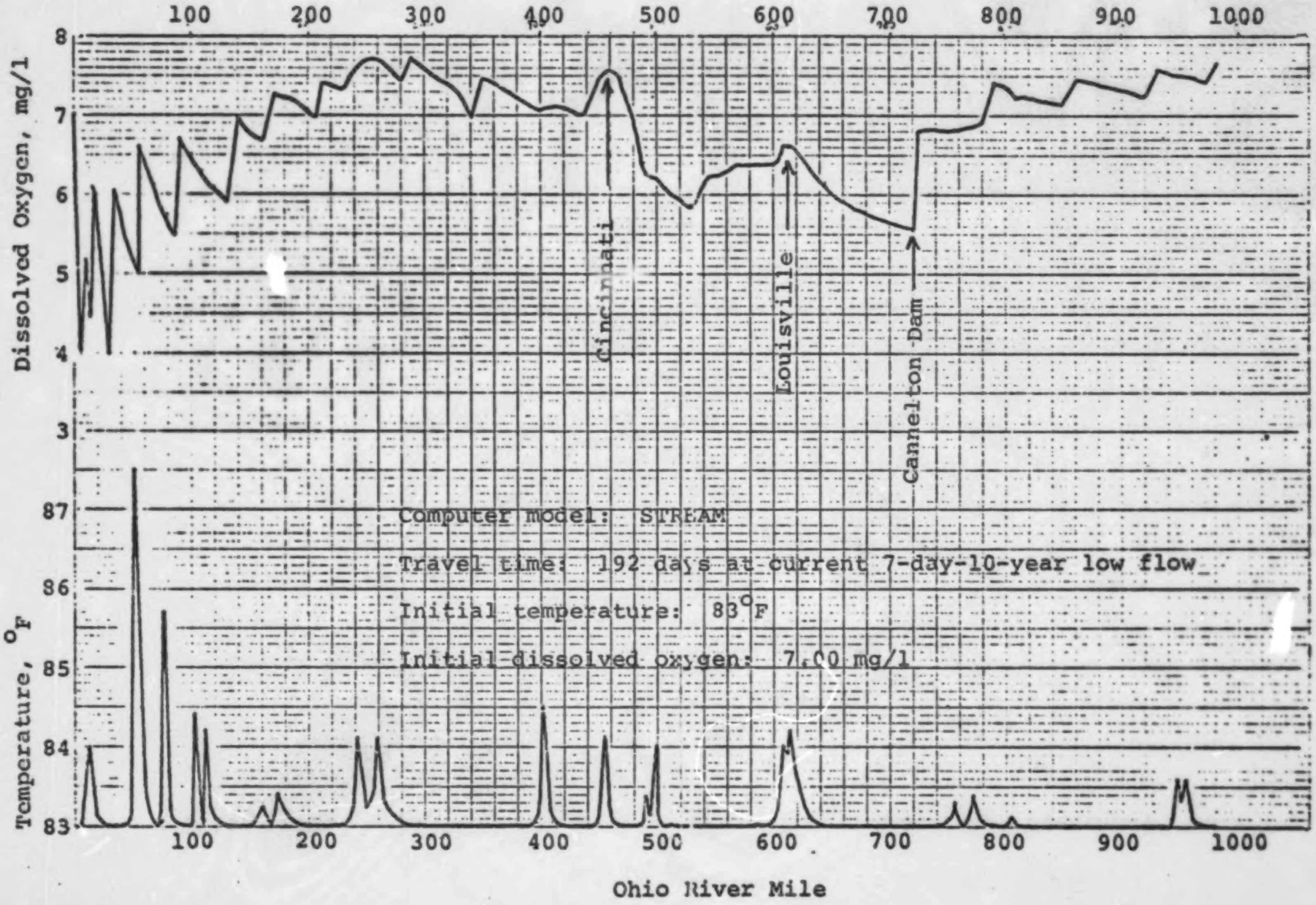
1. All of the ORBES region navigable waterways and their major tributaries currently show violations of at least two of the 20 reference standards listed in Table 1-3 at seasonal low flow. The Ohio River main stem shows violations for 11 of these standards under such conditions.

2. The conservative agents most frequently found at low flow concentrations in violation of the reference standards are phosphorus, iron, manganese, copper and chromium.

3. Of the major rivers studied, the Ohio River main stem appears to be the most heavily impacted at low flow in terms of conservative agent concentrations.

4. The model STREAM predicts violation of the dissolved oxygen standard (5 mg/l) in the upper Ohio River at low flow; the maximum temperature rise across the river under this condition was 4.5°F which also occurred in the upper Ohio. (The standard for temperature rise established by ORSANCO in 1970 was 5°F.)

Figure 1-6 Temperature and dissolved oxygen profiles for the 1977 Ohio River main stem base case.



Computer model: STREAM

Travel time: 192 days at current 7-day-10-year low flow

Initial temperature: 83°F

Initial dissolved oxygen: 7.00 mg/l

Reproduced from best available copy.

Chapter 1

References

(1) U.S. Army Coprs of Engineers, Reservoirs and Waterways; Identification and Assessment of Environmental Quality Problems and Research Program Development, by J.S. Keely, J.L. Maklock, J.W.Barko, D. Gunnison and J.D.Westoff, Technical Report E-78-1 (Washington, D.C.: Office, Chief Engineers, U.S. Army, 1978.

(2) Leuthart, C. and Spencer, H.T. Recreation on the Ohio, Water Resources Bulletin 15:220-226, 1979.

(3) Brill, E.D. Final ORBES Report for CORT modeling (University of Illinois), 1979.

(4) Ohio River Valley Water Sanitation Commission (ORSANCO) collected reports of the Power Industry Advisory Committee (Obtainable from ORSANCO, 414 Walnut Street, Cincinnati, Ohio, 45202. 1977-1979.

Chapter 2.0 Classification and Distribution of Fishes of the ORBES Region

The fish resources of the ORBES region are both abundant and diverse. Species found in the region are listed in systematic order in Appendix A of this document. There are 258 species in 70 genera, and 27 families in this listing. An alphabetical listing of the fish species by scientific name with corresponding common name is provided in Appendix B.

The distribution of these 258 species in 70 of the major waterways of the ORBES region is presented in matrix form in Appendix C. Following that display are separate listings of the fishes recorded in each waterway. The rivers and streams chosen for this study are the major waterways of the six ORBES states of Illinois, Indiana, Kentucky, Ohio, Pennsylvania and West Virginia. Because of its length and the changes in distribution of its fishes within main stem boundaries, the Ohio was divided into four sections. A discussion of the fishes of the Ohio main stem follows in this chapter.

2.1 Historical data and fish surveys

The fish species of the Ohio main stem have been of considerable interest to researchers in the past as well as the present. Maintenance of an accurate census of fishes in the main stem and changes in their distribution is addressed by several groups such as the U.S. Fish and Wildlife,the

Ohio River Valley Water Sanitation Commission (ORSANCO), and EPA, though these records are kept for differing reasons. The "Summary of Ohio River Fishery Surveys, 1968-1976" by Preston and White (1), cites changes in land-use involving deforestation, agriculture and mining as the cause of increase siltation which occurred in the late 1800's and early 1900's. Subsequent to this, the number of bullhead catfish, goldeye, skipjack herring, gizzard shad and spotted bass increased. Mining in the 1920's and industrial expansion of the 1930's further added to the degradation of the waterway. Lachner (2) reported that by the 1950's, 24 species reported earlier from the upper Ohio were, at that time, either missing or reported in low numbers.

The review of the literature documents the occurrence of 150 fish species in the Ohio main stem. From the collections made between 1968 and 1977, Preston and White report 82 species in the Ohio. According to that study, the sole sampling methods employed was the application of rotenone to the lock chamber and subsequent recovery of affected fish.

It must be emphasized at this point that while this sampling technique was sufficient for studies such as the one undertaken by Preston and White, the results of a single sampling technique should not be taken as an assessment of the entire fish population. The banks and backwater areas of the Ohio main stem provide a variety of habitats for fish populations than the main channel alone. And indeed, as shall be discussed later, these bank and backwater areas are of a prime concern to the future of fish populations in the Ohio.

Additional sampling techniques including electroshocking, seining and the use of various types of fish nets and traps would provide additional information. Such sampling techniques were used by several of the authors referenced in Appendix C.

The sampling stations used in the Preston and White study (1) are listed in Table 2-1. Even though the Preston and White (1) study included only rotenone sampling, it documents important changes in the distribution of fish species in the Ohio. The authors created seven categories of fishes based on "phylogenetic relationships, ecologic and economic factors." The categories and respective fish groups are listed in Table 2-2.

Fish biomass was also recorded from each sampling station. The total weight in kilograms for the years of the collections are listed in Table 2-3. The biomass data from each collection station was converted to a weight per area value. It is stated in the study, "These data show a greater fish biomass in all the downstream stations (MP 436-939) in both subperiods of the study (1968-1970, 1975-1976)" (1).

Results indicate that in the upstream samples: (1) basses , sauger and drum are extending their

TABLE 2-1 LOCK CHAMBERS AND MILE POINT OF COLLECTION SITES

Locks and Dams	River Mile Point
Dashields	MP 13.3
Montgomery	31.7
New Cumberland	54.4
Pike Island	84.3
Hannibal	126.4
No. 15	129.1
Belleville	204.0
No. 23	231.0
Gallipolis	279.2
Greenup	341.0
Meldahl	436.4
Markland	531.5
McAlpine	607.0
Cannelton	720.7
Newburgh	778.7
Uniontown	846.0
No. 50	876.8
Smithland	918.5
No. 52	938.9

from Preston and White (1)

TABLE 2-2 CATEGORIES OF FISH WITH RESPECTIVE FISH TYPE

Category	Group Includes
Forage A	Minnows, shiners, and chubs
Forage B	Shad and herring
Sport A	Sunfishes and basses
Sport B	Walleye, sauger, and perches
Commercial	Channel catfish, blue catfish, buffalofishes and freshwater drum
Rough	Carp, bullhead catfish, and suckers
Miscellaneous	All others

from Preston and White (1).

TABLE 2-3 FISH BIOMASS PER COLLECTION YEAR.

Year of Collection	Weight in Kilograms (pounds)
1968	2390 (5258)
1969	1985 (4367)
1970	1549 (3408)
1975	2211 (4864)
1976	3434 (7555)

from Preston and White (1).

distribution upstream; (2) decreases in biomass in upstream samples were due mainly to reduction in carp and bullhead catfish; (3) channel catfish and freshwater drum increased upstream in latter years; (4) more minnows and shiners are found upstream; (5) channel catfish, skipjack herring and spotted bass are increasing in the upper 100 miles; (6) white catfish were collected only in the upper portion of the river (1).

Changes in the downstream portion of the river in addition to increases in biomass include: (1) forage B and commercial categories increased downstream; (2) commercial forms are a dominant form in the downstream portion; (3) sport A and B were more abundant in the downstream portion (MP 300-900); (4) rough fish biomass decreased downstream; (5) blue catfish, threadfin shad and paddlefish are limited to the lower Ohio, though; (6) the paddlefish and buffalofish are extending their range from the lower Ohio into the middle range (1).

An increase in species was reported by Preston and White (1) over an earlier, similar study (3): "Eight species were collected in this study that were not reported in the 1957-59 study. These are alewife, _Alosa pseudoharengus_; northern pike, _Esox lucius_; bigeye shiner, _Notropis boops_; pugnose minnow, _Notropis emiliae_; white catfish, _Ictalurus catus_; striped bass, _Morone saxatilis_; and channel darter, _Percina copelandi_."

It is concluded from that study (3) that fish biomass has increased throughout the length of the Ohio main stem. In the downstream portion of the river, more of the categories of fish can be found and these include forage, sport, and commercial species.

2.2 Categorization of fishes in the ORBES region.

For this report, a different categorization scheme was developed. The system is based on the frequency of occurrence of each species in the ORBES waterways. Occurrence of a species in a single river or stream is viewed as a special event. These fishes are classed as isolated. Fishes recorded in 2 to 10 rivers were classed as limited; dispersed fishes occur in eleven to fifty-mine rivers. The fishes which occurred in over fifty-nine of the ORBES rivers were classed as ubiquitous. The number of fish in each of these classes and the percentage of the total composing each class are listed in Table 2-4.

The thirty-six species classed as isolated are listed in Table 2-5 with the stream or river in which they occur. It should be noted that fishes classed as isolated in the ORBES region are not necessarily isolated when areas outside this region are included. For example, five species are classed as isolated in the Mississippi River. If other streams and rivers of the Mississippi drainage were included, these fishes would very likely have a much broader distribution. It should also be noted that only one of the

TABLE 2-4

DISTRIBUTION OF FISH SPECIES AMONG SEVENTY RIVERS IN THE ORBES REGION[a]

	Number	Percent
Isolated:		
in a single river	36	13.9
Limited:		
in two to ten rivers	97	37.6
Dispersed:		
in eleven to fifty-nine rivers	101	39.1
Ubiquitous:		
in sixty or more rivers	24	9.3
	258	100.0

[a] The Ohio River main stem comprises four study areas: Upper from MP 0 to 317, Upper-mid from MP 317 to 471, Middle from MP 471 to 630, and Lower from MP 630 to 981.

TABLE 2-5

FISH FOUND IN ONLY ONE ORBES RIVER OR STUDY REACH[a]

OBION CREEK - BAYOU DU CHIEN	
Etheostoma swaini	Gulf darter
Lepomis marginatus	Dollar sunfish
Notropis camurus	Bluntface shiner
Notropis maculatus	Taillight shiner
Noturus hildebrandi	Least madtom
Noturus phaeus	Brown madtom
TENNESSEE	
Etheostoma neopterum	Lollipop darter
CUMBERLAND	
Etheostoma microlepidum	Smallscale darter
Etheostoma obeyense	Barcheek darter
Micropterus coosae	Redeye bass
LOWER OHIO	
Notropis venustus	Blacktail shiner
GREEN	
Etheostoma bellum	Orangefin darter
Moxostoma atripinne	Blackfin sucker
Typhlichthys subterraneus	Lesser blindfish
SALT	
Amblyopsis spelaea	Mammoth cave blindfish
Lepomis cyanellus x humilis	Hybrid sunfish
Lepomis cyanellus x megalotis	Hybrid sunfish
Lepomis humilis x macrochirus	Hybrid sunfish
GREAT MIAMI	
Parexoglossum laurae hubbsi	Western tonguetied chub
SCIOTO	
Clinostomus vandoisulus	Rosy dace
Noturus trautmani	Scioto madtom

TABLE 2-5 (Cont'd.)

FOX	
Hybognathus hankinsoni	Brassy minnow
KANKAKEE	
Notropis texanus	Weed shiner
GUYANDOTTE	
Semotilus margarita	Pearl dace
ILLINIOIS	
Pungitius pungitius	Ninespine stickleback
EEL	
Moxostoma rubreques	Greater redhorse
KANAWHA	
Moxostoma rhothroecum	Torrent sucker
Notropis cerasinus	
Notropis rubricroceus	
MONONGAHELA	
Lepomis cyanellus x macrochirus	Hybrid sunfish
NEW RIVER	
Exoglossum maxillingua	Cutlips minnow

---

[a] The Ohio River main stem comprises four study areas: *Upper* from MP 0 to 317, *Upper-Mid* from MP 317 to 471, *Middle* from MP 471 to 630, and *Lower* from MP 630 to 981.

fishes in the ORBES region in recorded on the federal list of endangered and threatened wildlife and plants (4). This single occurrence is that of Noturus trautmani, the Scioto madtom, of the Scioto River drainage in Ohio.

Twenty-four fish species were found in 60 or more of the 70 streams and rivers of the ORBES region. A listing of these fish is found in Table 2-6. The importance of the distribution of the ubiquitous species is discussed further in Chapter 3.

TABLE 2-6

UBIQUITOUS FISH SPECIES OF THE ORBES REGION

Ambloplites rupestris	Rock bass
Campostoma anomalum	Stoneroller
Carpiodes cyprinus	Quillback
Catostomus commersoni	White sucker
Cyprinus carpio	Carp
Dorosoma cepedianum	Gizzard shad
Etheostoma Nigrum	Johnny darter
Ictalurus melas	Black bullhead
Ictalurus natalis	Yellow bullhead
Ictalurus punctatus	Channel catfish
Lepomis cyanellus	Green sunfish
Lepomis macrochirus	Bluegill
Lepomis megalotis	Longear sunfish
Micropterus dolomieui	Smallmouth bass
Micropterus salmoides	Largemouth bass
Moxostoma erythrurum	Golden redhorse
Notropis cornutus chrysocephalus	Central common shiner
Notropis spilopterus	Spotfin shiner
Notropis volucellus	Mimic shiner
Percina maculata	Blackside darter
Phenacobius mirabilis	Suckermouth minnow
Pimephales notatus	Bluntnose minnow
Pomoxis annularis	White crappie
Semotilus atromaculatus	Creek chub

Chapter 2

References

(1) Preston, H.R., and White, G.E. Summary of Ohio River Fishery Surveys, 1968-1976. EPA 903/9-78-009. Surveillance and Analysis Division, Region III, U.S. Environmental Protection Agency; Philadelphia, Pennsylvania, 19106, 1978.

(2) Lachner, E.A. The Changing Fish Fauna of the Upper Ohio Basin, pp. 64-78. In Man and the Waters of the Upper Ohio Basin. Special Publication Number 1, Pymatuning Laboratory of Field Biology, University of Pittsburgh, Pittsburgh, Pennsylvania, 1956. (Cited in reference 1).

(3) Ohio River Valley Water Sanitation Commission. Aquatic Life Resources of the Ohio River. ORSANCO. Cincinnati, Ohio, 1962.

(4) Department of the Interior. List of Endangered and Threatened Wildlife and Plants. Federal Register, Vol. 44, No.12, 1979.

Chapter 3.0 Fish Habitats and Aquatic Ecology

Within each river or stream of the ORBES region are a variety of habitats suitable for fish life. These habitats will vary with respect to flow characteristics, stream-bed, size and depth of the stream or river, presence or absence of vegetation and other debris, and water quality. Because of anatomical modifications or physiological requirements, various species of fish will be better adapted to some habitats than others, and totally excluded from some.

The degree to which habitat requirements in the ORBES region influence the distribution of fishes is shown by the following examples adapted from the *Fishes of Illinois* by Philip Smith (1). Examples were chosen from this particular text because of the extensive data base for the state, because of the excellent graphics and because it is the most recent reference. Some fishes have very general and non-specific requirements and, thus, are found in many streams. Such is the case of the carp (*Cyprinus carpio*) as shown in Figure 3-1. Others are quite specific in their requirements or have been eliminated from all former habitats except a few. In Illinois the pallid shiner (*Notropis amnis*) occurs only in the upper waters of the Mississippi (Figure 3-2). The size of the stream or river can also affect distribution. The river shiner (*Notropis blennius*) is found only in major rivers of Illinois

Figure 3-1

Distribution of the carp in Illinois.

from Smith (1)

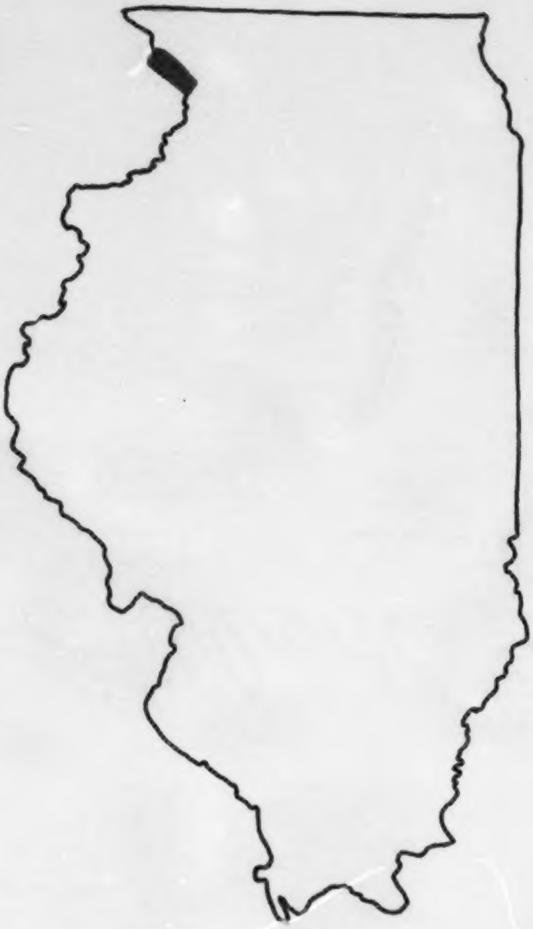


Figure 3-2

Distribution of the pallid shiner in Illinois.

from Smith (1)

(Figure 3-3), while the northern brook lamprey finds suitable habitats only in small stream headwaters (Figure 3-4). River drainage is one of the bases of differences among species. The mountain madtom (*Noturus eleutherus*) as shown in Figure 3-5, is found only in the Ohio drainage and not in the Mississippi. The opposite case is true for the bigmouth shiner (*Notropis dorsalis*) (Figure 3-6) which is found in the Mississippi drainage but not that of the Ohio. Geographic location and habitat type, regardless of major river drainage, influences distribution as well. Southern distribution is characteristic of the blackspot topminnow (*Fundulus olivaceous*) shown in Figure 3-7. The horneyhead chub (*Nocomis biguttatus*) is found only in the northern part of Illinois (Figure 3-8). As demonstrated with the examples from Illinois, the distribution of fishes is not equal throughout all streams. Differences in habitat requirements and availability, in addition to biotic associations, influence the distribution of fishes in all waterways.

3.1 The aquatic biota of the ORBES region

As noted in Chapter 1.0, the ORBES region has as diverse an inland aquatic setting as possible in the United States. In the 70 streams and rivers (see Figure 1-2) chosen for a special literature study, 258 species of

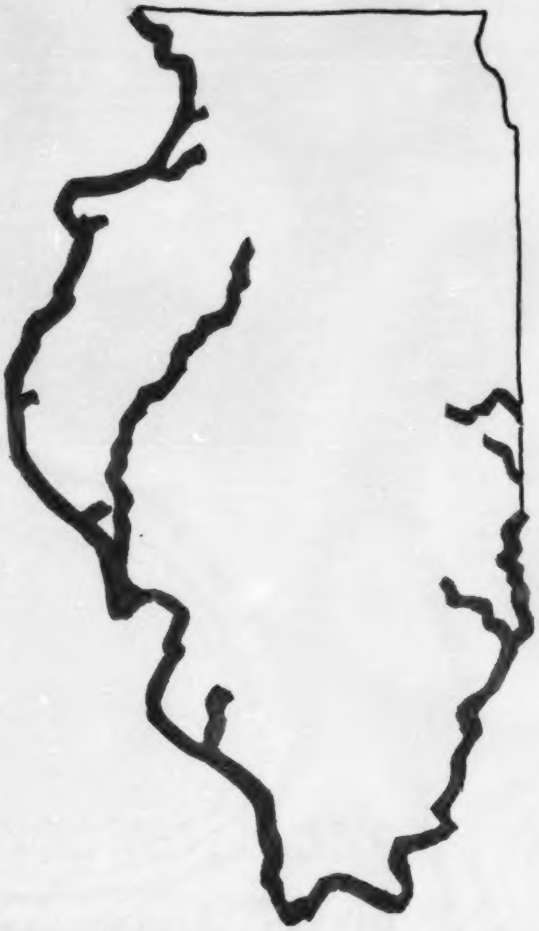


Figure 3-3

Distribution of the river shiner in Illinois.

from Smith (1)

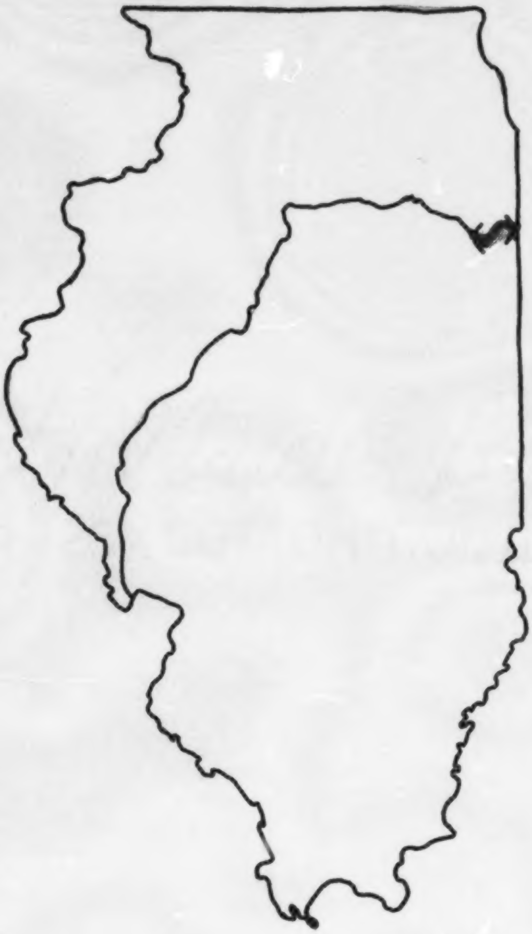


Figure 3-4

Distribution of the northern brook lamprey in Illinois.
from Smith (1)

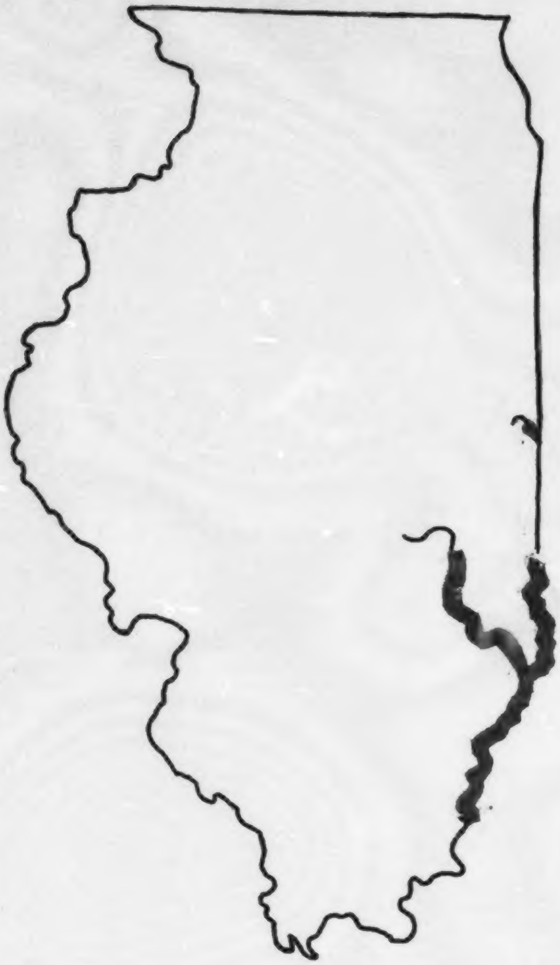


Figure 3-5

Distribution of the mountain madtom in Illinois.

from Smith (1)

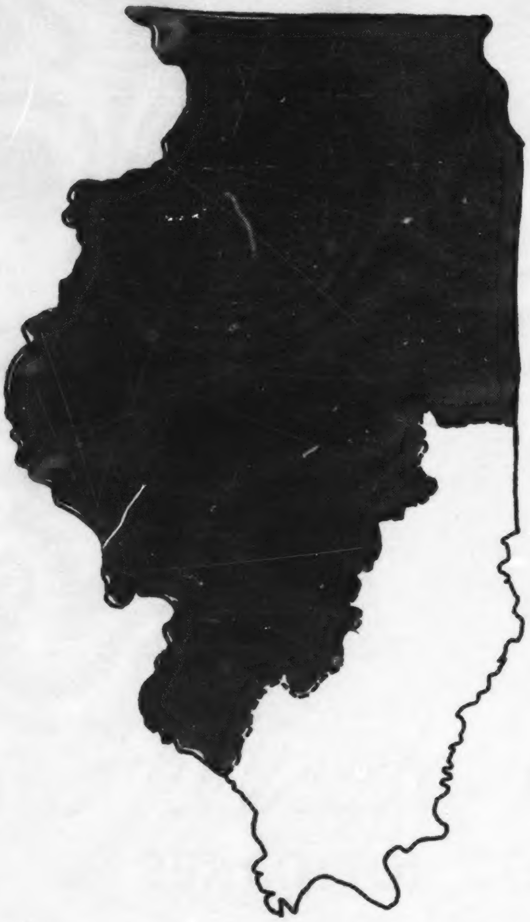


Figure 3-6

Distribution of the bigmouth shiner in Illinois.

from Smith (1)

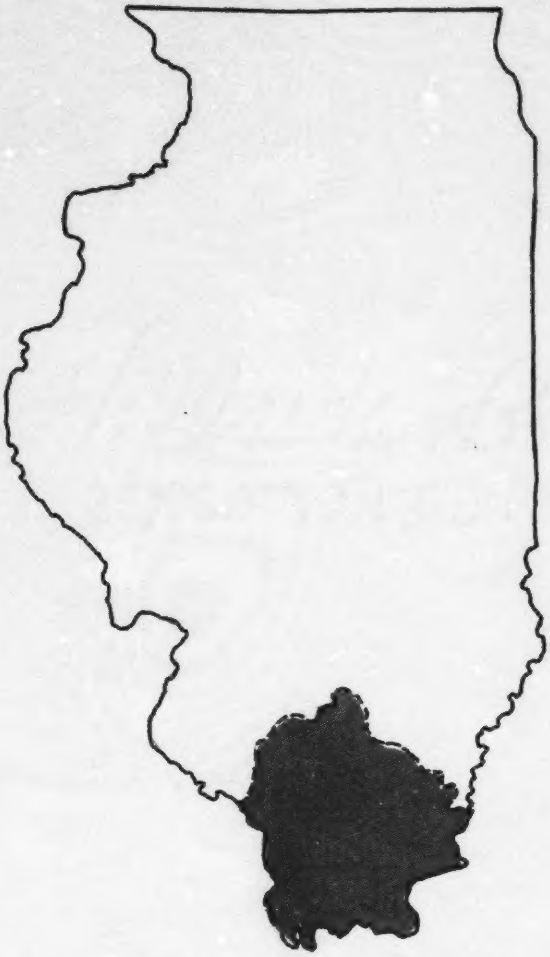


Figure 3-7

Distribution of the blackspotted topminnow in Illinois. from Smith (1)

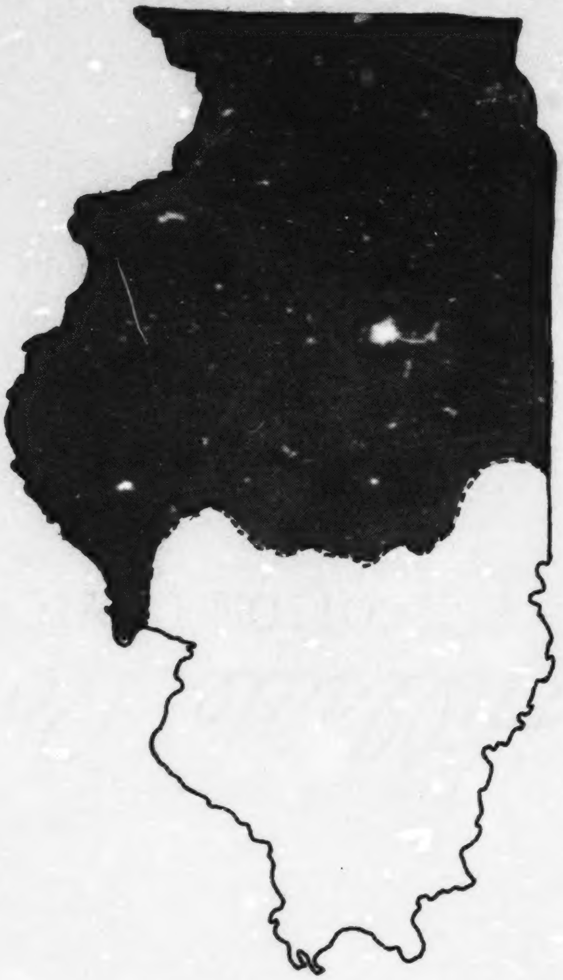


Figure 3-8

Distribution of the hornyhead chub in Illinois. from Smith (1) fish were reported. In addition, the distribution patterns of 58 amphibians and 75 reptiles touch upon some part of the ORBES region (2). The United States Department of the Interior (USDI) listed in 1973 the following fishes which occur in the ORBES region as having an undetermined status[1]; the pallid sturgeon (*Scaphirhynchus albus* - Figure 1-2, map number 23), the Kanawha minnow (*Phenacobius teretulus* - map number 67), the sharpnose darter (*Percina oxyrhyncha* - map numbers 7, 9, 10, 14, 65, 66, 68, 69) and the olive darter (*Percina squamata* - map numbers 2, 3) (3). In addition, the USDI then listed the lake sturgeon (*Acipenser fulvescens* - map number 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17, 23, 41, 45, 60, 65) as threatened and the Illinois chorus frog (*Pseudacris streckeri* illinoensis) as undetermined. Currently, the January 12, 1979 Federal Register lists only the Scioto madtom (Noturus trautmani - map number 17) as endangered (4). Most states have a list of rare, endangered or threatened species within their borders as well. These lists are often more extensive than those in the Federal Register and tend to reflect the status of a species only within particular state boundaries.

---

[1] The following definitions originate with The Endangered Species Conservation Act of 1969. The term "threatened" as used in the definition of undetermined status applies to species or subspecies that are so few in numbers or so threatened by present circumstances, as to be in danger or extinction - in other words, to species considered endangered (3, p. 5).

Undetermined status—a species or subspecies that has been suggested as possibly threatened with extinction, but about which there is not enough information to determine its status (3, p. 203).

Endangered—a species or subspecies whose existence is endangered because its habitat is threatened with destruction, drastic modification, or severe curtailment, or because of over-exploitation, disease, predation, or because of other factors, and that its survival requires assistance (3, p. v).

The June 14, 1976 Federal Register also listed, for the first time, 26 clams as endangered. Of these, 7 are found in the ORBES region and are listed in Table 3-1. For sake of reference, the stream system noted as currently having an endangered fish species is shown in Figure 3-9.

The endangered species list in the Federal Register and similar state specific list give the researcher doing regional analysis some guidance, but they cannot in themselves be taken as final authority. Range boundaries for species cross state lines (and ORBES boundaries as well), and thus, an analysis involving several states becomes exceptionally difficult if the nature of the data base varies from state to state. Fortunately for most the fishes of the ORBES region, stream records exist in relation to watersheds within states or, as in the case of the Mississippi, Ohio and Wabash, for major rivers which make up state lines. This makes the development of an ORBES region species list for the fishes a possibility.
Given such a list, and given knowledge of species habitat

TABLE 3-1

ENDANGERED MOLLUSCS OF THE ORBES REGION

	Scientific Name	Known ORBES Distribution	Portion of Range where Threatened or Endangered
Cumberland bean	*Villosa trabalis*	KY	Entire
Higgin's eye	*Lampsilis higginsi*	IL	Entire
Pink mucket	*Lampsilis orbicucata orbiculata*	WV	Entire
Sampson's mussel	*Epioblasma sampsoni*	IN, IL	Entire
Tubercleo-blossom	*Epioblasma torulosa torulosa*	KY, IL, WV	Entire
White cat's eye	*Epioblasma sulcath delicath*	OH, IN	Entire
Riffle shell clam	*Epioblasma walkeri*	KY	Entire

Source: Federal Register, Volume 44, No. 121 January 17, 1979
(page 3652).

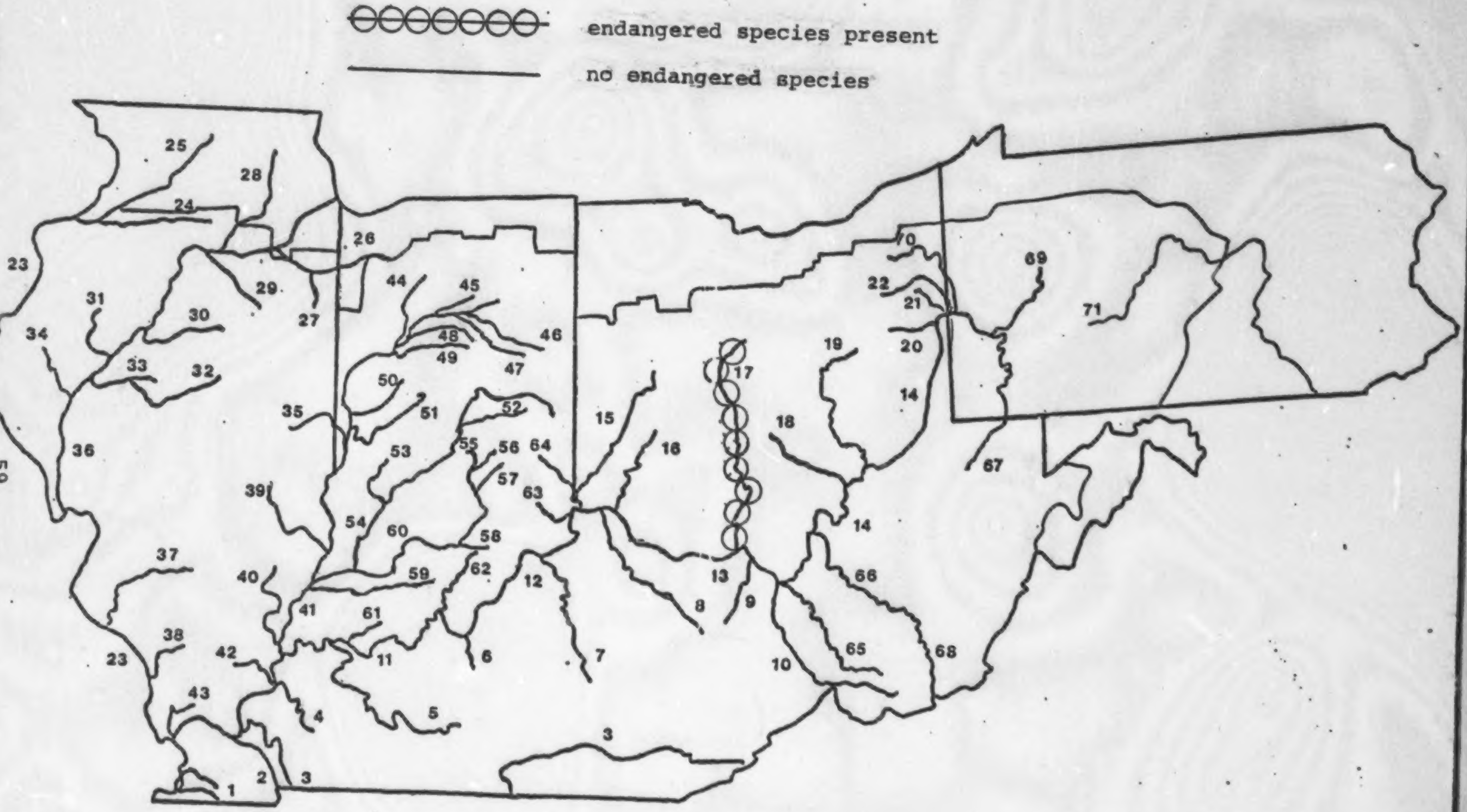

endangered species present
no endangered species
23
25
28
24
26
31
30
29
27
44
45
34
33
32
48
49
46
47
50
51
35
52
36
53
55
56
64
57
63
39
54
60
58
37
40
59
62
12
41
61
38
42
11
6
7
43
4
5
3
2
1
3
15
16
17
18
19
20
14
13
8
9
10
14
66
65
68
70
22
21
69
71
67
23

Figure 3-9 ORBES streams having endangered fishes.

requirements and distributional patterns, one can then develop methodologies for evaluating the existing condition of the region's aquatic habitat, and for evaluating scenario impacts.

Seventy of the 71 ORBES streams and rivers shown in Figure 1-2 drain to the Mississippi and as such, were considered a group in developing analysis methodologies. The Susquehanna (map number 71) drains to the Atlantic and has a fauna geographically isolated from the rest; subsequently, it had to be considered apart.

A species regionally isolated in a specific stream should not be considered endangered, except in the case of the Scioto madtom (*Noturus trautmani*). Many are hybrids of more common types, particularly among the sunfishes; others are peripheral and occur in the ORBES region by virtue of its simply bordering on their range. Nonetheless, the presence of isolated and limited species in a stream was taken as an indication of the stream's aquatic standing in terms of habitat health and diversity. This in turn, led to the development of a regional index (RI) calculated as follows for each of the 70 streams:

$$RI = \frac{4(I) + 3(L) + 2(D) + 1(U)}{(I + L + D + U)}[1]$$

---

[1] The equation

$$RI = \frac{4(I) + 3(L) + 2(D) + 1(U)}{(I + L + D + U)}$$

(Continued at the bottom of the next page.)

where I, L, D, and U represent the number of isolated, limited, dispersed and ubiquitous species in a given stream, respectively as defined in Table 2-4. These indicies are given in Table 3-2.

The index RI has a possible range of 1 to 4; a value of 1 would be for a stream having only ubiquitous species while 4 would be for a stream containing only regionally isolated species. For the ORBES region, the RI values range from 1.36 for the Spoon River, a small tributary of the Illinois River in a region of intense farming, to 2.34 for the much larger Kanawha River[2] coming out the mountains of West Virginia. These indicies were then averaged for the region by means of a regression function set up to give best estimates of expected RI values per stream species total. The function used was:

$$(\widehat{RI})_i = a + b(T_i);\ T_i \geq 25 \text{ but } \leq 128,$$

---

[1] is of the form

$$Y_i = B_1X_1 + B_2Y_2 + B_3X_3 + \ldots + BnXn$$

which is a familiar regression function. In the case of (RI) terms, analogous to regression coefficients have been selectively chosen (1, 2, 3 and 4) and an index calculated. These coefficients represent assumptions, or judgements, on the part of the analyst as to the ecological value of a stream based upon evidence of its supporting a diverse fauna.

[2] The Kanawha, New and Gauley River systems have a rich fauna established above the city of Charleston, WV. Below Charleston this fauna is somewhat diminished.

TABLE 3-2

CLASSIFICATION AND PROTECTION LEVELS FOR ORBES WATERWAYS

Stream		Regional Index	Number of Species	Protection Level
Kentucky				
Figure 1-2 Map Number				
1	Bayou de Chien and Obion Creek	1.86	108	A
2	Tennessee River	2.04	101	A
3	Cumberland River	2.10	128	A
4	Tradewater River	1.70	70	B
5	Green River	2.00	122	A
6	Salt River	1.88	98	A
7	Kentucky River	1.91	106	A
8	Licking River	1.83	96	A
9	Little Sandy River	1.75	83	B
10	Big Sandy River	1.81	90	A
11	Ohio River from the Salt River to the Mississippi	2.00	94	A
12	Ohio River from the Port of Cincinnati, OH to the Salt River	1.86	80	A
13	Ohio River from the Big Sandy River to the Port of Cincinnati	1.81	73	A
14	Ohio River from Pittsburgh, PA to the Big Sandy River	1.85	92	A

TABLE 3-2 (continued)

CLASSIFICATION AND PROTECTION LEVELS FOR ORBES WATERWAYS

Stream		Regional Index	Number of Species	Protection Level
Ohio				
Figure 1-2 Map Number				
15	Great Miami River	1.83	81	A
16	Little Miami River	1.76	82	B
17	Scioto River	1.88	111	A
18	Hocking River	1.70	64	B
19	Muskingum River	1.80	86	B
20	Big Yellow River	1.56	41	B
21	Little Beaver River	1.65	51	B
22	Mahonig River	1.61	41	B
Illinois				
23	Mississippi River	2.06	100	A
24	Green River	1.57	44	B
25	Rock River	1.79	66	B
26	Kankakee River	1.86	87	B
27	Iroquois River	1.42	26	B
28	Fox River	1.78	41	A
29	Vermilion I River	1.74	62	A
30	Mackinaw River	1.51	35	B
31	Spoon River	1.36	25	B
32	Sangamon River	1.64	53	B
33	Salt River	1.69	59	B
34	La Moine River	1.58	38	B
35	Vermilion II River	1.51	35	B

TABLE 3-2 (continued)

CLASSIFICATION AND PROTECTION LEVELS FOR ORBES WATERWAYS

Stream		Regional Index	Number of Species	Protection Level
Illinois				
Figure 1-2 Map Number				
36	Illinois River	1.96	108	A
37	Kaskaskia River	1.87	90	A
38	Big Muddy River	1.91	57	A
39	Embarras River	1.78	79	B
40	Little Wabash River	1.73	66	B
41	Wabash River	1.88	113	A
42	Saline River	1.63	32	A
43	Cache River	1.76	59	A
Indiana				
44	Tippecanoe River	1.77	77	B
45	Eel River I	1.73	62	A
46	Salamonie River	1.60	43	B
47	Mississinewa River	1.40	30	B
48	Deer Creek	1.56	38	B
49	Wildcat Creek	1.60	52	B
50	Sugar Creek I	1.67	58	B
51	Raccoon Creek	1.74	72	B
52	Fall Creek	1.58	40	B
53	Eel River II	1.60	48	B
54	West Fork of the White River	1.70	67	B
55	Sugar Creek II	1.74	57	A

TABLE 3-2 (continued)

CLASSIFICATION AND PROTECTION LEVELS FOR ORBES WATERWAYS

Stream		Regional Index	Number of Species	Protection Level
Indiana				
Figure 1-2 Map Number				
56	Big Blue River I	1.56	41	B
57	Flat Rock Creek	1.64	44	A
58	Muscatatuck River	1.67	70	B
59	Patoka River	1.65	75	B
60	East Fork of the White River	1.75	55	A
61	Little Pigeon Creek	1.70	30	A
62	Big Blue River II	1.75	66	A
63	Laughery Creek	1.42	24	B
64	Whitewater River	1.74	59	B
West Virginia				
65	Guyandotte River	2.01	126	A
66	Kanawha River	2.10	118	A
67	Monongahela River	1.75	36	A
68	New River	2.08	52	A
Pennsylvania				
69	Allegheny River	1.70	44	A
70	Beaver River	1.53	28	B
71	Susquehana River			

where $(RI)_i$ is the estimate of $\mu(RI)_i$ for stream species, total (T_i) and a and b are least square estimates of intercept and regression coefficients, respectively. This function's parameters were found to have the following values:

$$(\widehat{RI})_i = 1.39 + 0.0053(T_i);\ r = +0.72.$$

A plot of the function and its data base is given in Figure 3-10.

Protection levels[1] were assigned to each of the 70 streams according to the following rules and definitions.

Level (A) — assigned to streams with observed RI values that exceed the expected (those streams falling above the line in Figure 3-10), and to streams with 90 or more species regardless of RI value. Ninety species in a given stream was determined from Figure 3-11 to be a cut-off point in species' number beyond which the number of ubiquitous species in each stream remained at a constant maximum.

Level (B) — assigned to streams with observed RI values that equal or fall below the expected (those streams on or falling below the line in Figure 3-10,

---

[1] The notion of protection levels is not unique to the ORBES study. Doudoroff and Shumway,(5) in discussing dissolved oxygen criteria, defined five protection levels for streams by assigning the highest level to streams having high dissolved oxygen requirements, for example native trout streams, and giving the lowest level to streams supporting only rough fish.

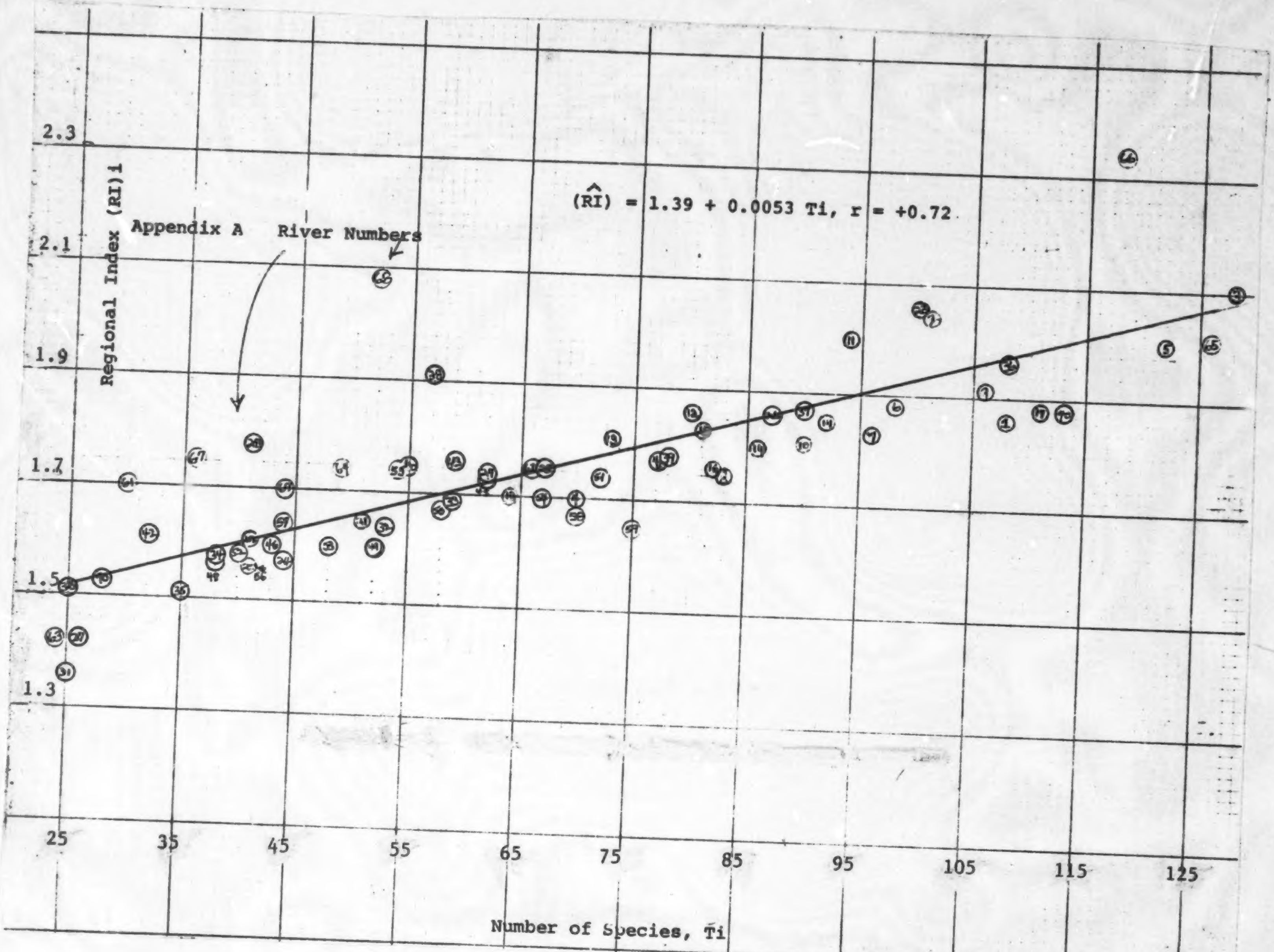


Figure 3-10 Expectation Function for Regional Indices

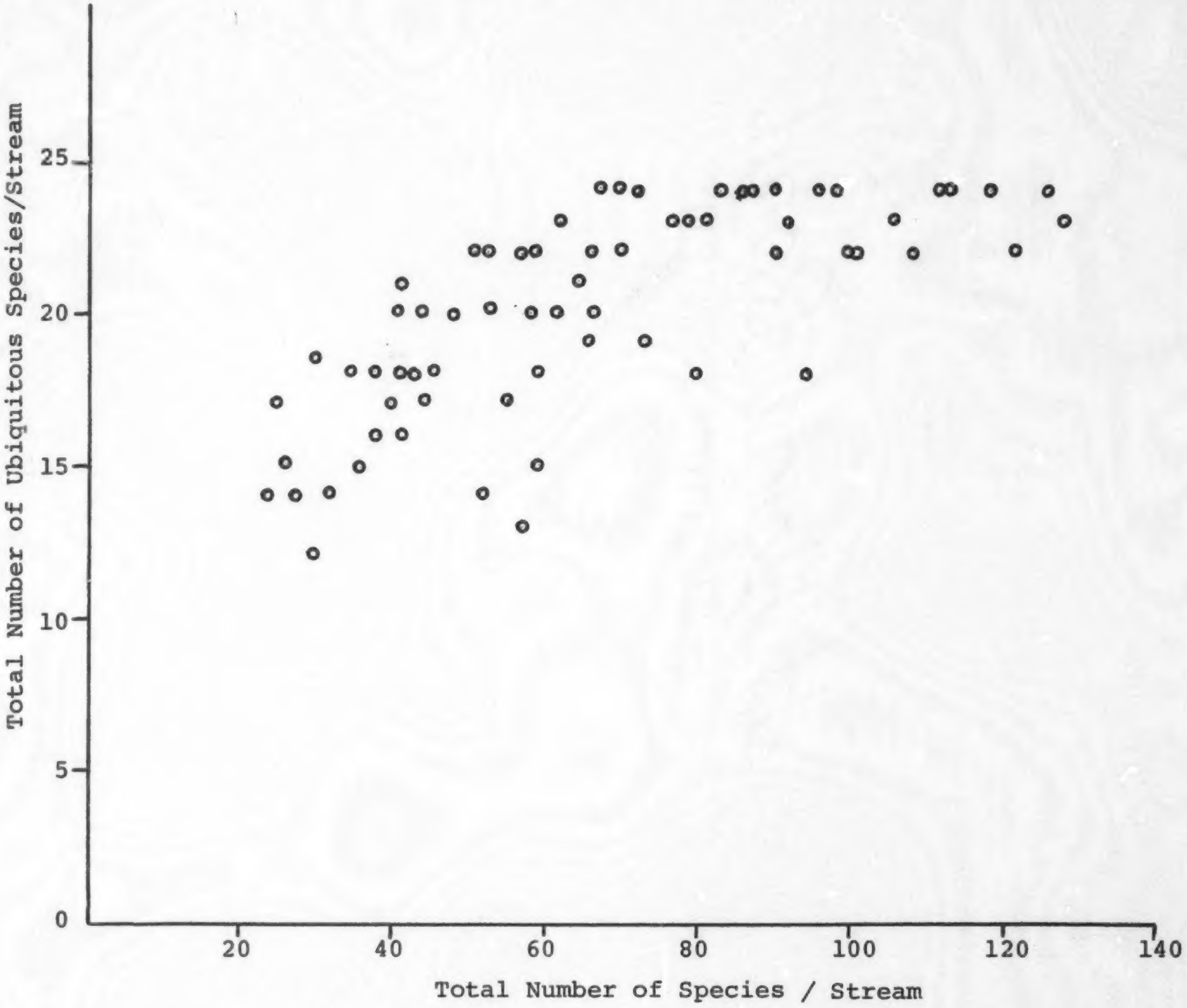


Figure 3-11 Ubiquitous species as a function of species total number.

and having fewer than 90 species.

Protection level (A) denotes a stream system having a rich fauna in so far as the region is concerned; (A) level streams are those considered especially significant ecologically and deserving of maximum protection possible. Protection level (B) denotes a stream system having a fauna not quite so rich as (A) and possibly working its way toward a more ubiquitous status; (B) level streams are more "commonplace" in a regional sense but still important and deserving of protection. It should be noted that some of the more popular sport fishes are among the ubiquitous species of the region. The distribution of (A) and (B) level streams is shown in Figure 3-12 and Table 3-2.

Protection levels (C) and (D) are possible but apply to streams of degraded quality. Of the streams studied, the upper and Ohio River, the Kanawha below Charleston, the Monongahela, and the lower Tradewater might well have been of such status in recent times (1950-1970). Improvements in wastewater treatment and land management have been of benefit to these systems and they have, to some degree, come back.

3.2 Navigable waterway ecosystems

All eleven of the ORBES region navigable waterways fall in protection level (A); of these the Tennessee,

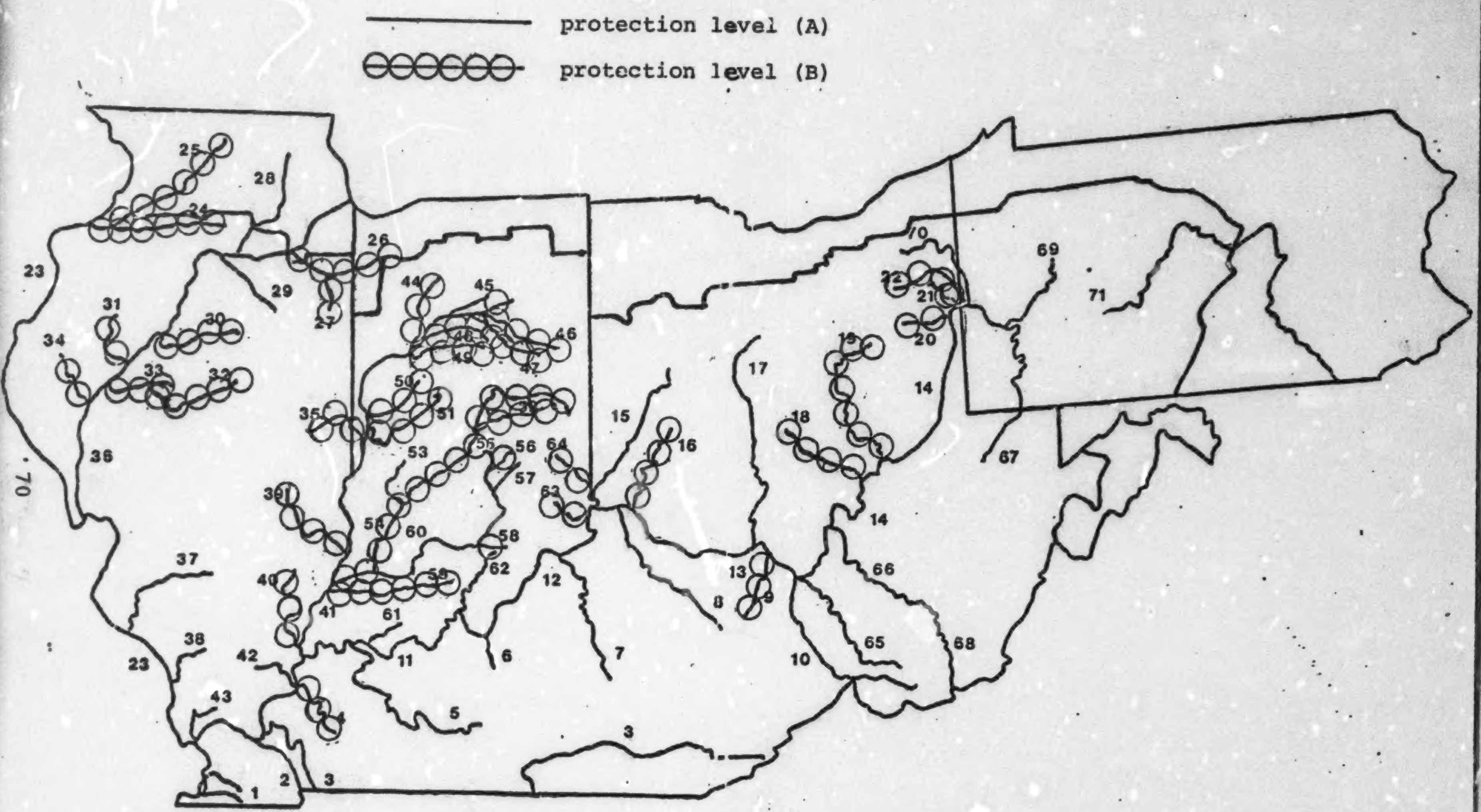

protection level (A)
protection level (B)
1
2
3
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
53
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71

Figure 3-12 Protection levels for ORBES streams.

Cumberland, lower Ohio and Mississippi rivers have both more than 90 species recorded in the recent record and observed regional indicies (RI_i) above the expected level ($\widehat{RI}_i$).

Concern on the part of U.S. EPA over water quality criteria conflicts involving the Ohio River main stem led the agency to publish a notice in the June 21, 1979 Federal Register. Its stated purpose was to "begin an administrative process designed to generate sufficient data and information to assist the states and EPA in developing compatible water quality standards applicable to the main stem of the Ohio River which can be used by EPA as the basis for approving or revising state standards" (6). The notice further identified the fish species listed in Table 3-3 as "important sensitive[1] game and food fish used with the protocol[2] to develop temperature criteria for the Ohio River." These species were selected by EPA as example organisms with full knowledge on the part of the agency that they

---

[1] "Important and sensitive species" are defined by EPA in the June 21, 1979 Federal Register as - "aquatic organisms and plant life which are of special significance to the public either because of their commercial, recreational or ecological value" (6).

[2] "Protocol" refers to "Temperature Criteria for Freshwater Fish: Protocol and Procedures," U.S. EPA, Washington, D.C., publication number EPA-600/3-77-061.

TABLE 3-3

FISH CHOSEN BY U.S. EPA AS EXAMPLE SPECIES FOR THE DEVELOPMENT OF TEMPERATURE CRITERIA FOR THE OHIO RIVER

Common Name	Scientific Name	ORBES Distribution[1]
Black crappie	*Pomoxis nigromaculatus*	D
Bluegill sunfish	*Lepomis macrochris*	U
Carp	*Cyprinus carpio*	U
Channel catfish	*Ictalurus punctatus*	U
Emerald shiner	*Notropis atherinoides*	D
Freshwater drum	*Aplodinotus grunniens*	D
Largemouth bass	*Micropterus salmoides*	U
Sauger	*Stizostedion canadense*	D
Smallmouth bass	*Micropterus dolomieui*	U
Smallmouth buffalo	*Ictiobus bubalus*	D
White bass	*Morone chrysops*	D
White crappie	*Pomoxis annularis*	U
White sucker	*Catastomus commersoni*	U

[1] D = well dispersed throughout the ORBES region

U = ubiquitous throughout the ORBES region represent only a fraction of the total species present. They were selected on the basis of major group representation, and according to the availability of knowledge of each fish's physiological characteristics. All are common to the Ohio main stem except for the white sucker (Catastomus commersoni) which at best is rare as a big river fish.

Typically, the white sucker is a small stream fish found more often up the Ohio's tributaries and at their points of confluence with the main stem. This species thus represents a sensitive inhabitant of important backwater areas along the main stem and its inclusion in the list is especially significant for that reason. The region's navigable waterways support a diverse fauna by virtue of having a variety of available habitats. The smallmouth bass (Micropterus dolomieui), for example, will tend to inhabit the waters of higher velocity below the navigation dams. These areas have riffles along their banks, and clean gravel bottoms. The Falls of the Ohio is an excellent example of such an area. Largemouth bass (Micropterus salmoides), white crappie (Pomoxis annularis) and bluegill sunfish (Lepomis macrochris), on the other hand, readily populate quiet areas above the dams. These latter three species have adapted well to conditions of silt, temperature fluctuation and variable flow. The black crappie (Pomoxis nigromaculatus), like the smallmouth as compared to the largemouth bass, is less common than its relative, Pomoxis annularis. This fish prefers clear water with abundant vegetation, rootwads, and quiet pools. Such areas as this still exist along the Ohio and Pomoxis nigromaculatus may be found there together with species of similar preference. The emerald shiner (Notropis atherinoides), an important forage fish on the EPA list and one of fifteen species of Notropis found in the Ohio, inhabits areas along the banks of backwater pools together with numerous other examples of aquatic plant and animal life. The ecosystems which have developed along the banks of these waterways are extremely important to maintain; indeed, it is not possible to over emphasize the need to protect these areas in that they are the mainstay of the ecosystem.

All in all, the EPA list of "important" and "sensitive" species includes representatives from every major habitat found in the region's navigable waterways and thus forms an important guide to the development of regional impact analysis methodologies. Debate, however, as to the list's validity as representative of the Ohio main stem community continues. The Power Industry Advisory Committee to ORSANCO commissioned an analysis of the list in response to the June 21, 1979 notice. The analysis was prepared by WAPORA, Inc. of Cincinnati, OH (7) and concluded in part that:

> Of the 13 species proposed by EPA as "important sensitive game and food fish" this report shows that only the bluegill, channel catfish, largemouth bass, and white crappie warrant such consideration over the entire length of the Ohio River Main Stem. Carp and emerald shiner might also be included because of their abundance throughout the Ohio River Main Stem; however, if EPA intended "food fish" to mean only fish used for human consumption, these two species are not appropriate.
>
> The black crappie, smallmouth bass, and white sucker have been shown to be inappropriate for consideration as "important sensitive game and food fish" for the Ohio River at the present time. Low tolerance to turbidity and siltation appear to be the major factors limiting Ohio River smallmouth bass and black crappie populations. The white sucker is a rare species in the Ohio River Main Stem. The white sucker prefers small stream and creek habitats.
>
> The smallmouth buffalo, sauger, white bass, and freshwater drum should not be considered "important sensitive game and food fish" over the entire length of the Ohio River; at the present time these four species are limited in distribution and abundance to the middle and lower sections of the Ohio River Main Stem.

EPA recommended temperature criteria for the Ohio River Main Stem based on protection of the selected fish species throughout their entire life cycle (for example, during spawning, embryo development, growth, and adult survival). These recommendations are summarized in Table 3-4. The authors of the WAPORA report (7) were critical of these EPA recommendations as well and stated that:

> 1) Several fish species selected by EPA are inappropriate either for part or all of the Ohio River Main Stem.

TABLE 3-4

RECOMMENDED TEMPERATURE CRITERIA FOR THE OHIO RIVER MAIN STEM

Period	Period Average	Maximum Limit	Species/System Protected
March 1-15	51°F	56°F	To provide for natural spring warming and sauger spawning.
March 16-31	54°F	59°F	Protection of sauger spawning.
April 1-15	59°F	64°F	Provides for sauger spawning and sauger embryo survival.
April 16-30	64°F	68°F	Period average provides for crappie, smallmouth bass and white bass spawning; limit protects black crappie and white sucker embryo.
May 1-15	70°F	78°F	Period average provides for carp, smallmouth buffalo, largemough bass and freshwater drum spawning; limit provides for smallmouth bass and white crappie embryo survival.
May 16-31	77°F	81°F	Period average provides protection for bluegill spawning; limit provides for largemouth bass embryo survival and for growth of May sauger larvae
June 1-15	81°F	82°F	Period average provides for black crappie growth and channel catfish spawning; limit provides for emerald shiner and smallmouth buffalo embryo survival.
June 16-30	84°F	--[1]	Period average provides for smallmouth bass growth.

[1] Reported period average and maximum temperatures are very close from June 1 - August 31.

Source: Federal Register, Volume 44, Number 121, June 21, 1979 (page 36255).

TABLE 3-4 (continued)

RECOMMENDED TEMPERATURE CRITERIA FOR THE OHIO RIVER MAIN STEM

Period	Period Average	Maximum Limit	Species/System Protected
July 1-31	84°F	--[1]	Period average provides for smallmouth bass growth.
August 1-31	84°F	--[1]	Period average provides for smallmouth bass growth.
September 1-30	82°F	84°F	Period average provides for growth of white crappie and white sucker; limit provides for smallmouth bass growth.

2) Actual spawning, embryo survival and growth of many of the selected species occurs over a more extended time interval and under higher natural temperatures than would be assumed by the EPA-established time intervals.

3) Natural temperature regimes within any given time interval proposed by EPA vary among locations along the length of the Ohio River and among years at any given location.

This debate is likely to continue into the future. However, current collection records for the Ohio main stem do confirm that the waterway is an abundant resource over its entire length and protection of all its 90 or so species has to be a consideration in any impact analysis.

3.3 Tributary ecosystems

All of the streams classified in protection level (B) occur as small tributaries of the major rivers and mostly in regions of intense farming. The only exceptions to this are the Tradewater and Little Sandy Rivers (Figure 3-12, map numbers 4 and 9, respectively), both of which receive substantial quantities of acid mine drainage.

Of the tributary systems classed in protection level (A), the Bayou de Chien/Obion Creek (Figure 3-12, map number 1) system is probably the most outstanding. This remarkable system of sluggish streams and wetlands holds 108 species, as compared to 94 for the lower Ohio

River main stem, and holds the ORBES region record for isolated species (eight). It occurs in an area famous among biologists for diverse aquatic habitats and species.[1]

The region's tributaries are considerably more varied than its navigable waterways and, thus, contain more varied and site-specific ecosystems. Some of these systems are entirely unique and, to a degree, protected. The major tributaries, those large enough to supply a power plant with cooling water or to supply a city of 25,000 population or more, are similar to navigable streams as bodies receiving organic and thermal discharges. However, levels and flow in the tributaries are not maintained as carefully as in navigable streams. Except for farming and mining, there is somewhat less development along these waterways, which therefore tend to support the few unique systems remaining. The major factors affecting tributary habitats in the ORBES region are siltation and stream desiccation.

3.4 Lake ecosystems

Like non-navigable tributaries, the region's lake systems are varied and contain some unique ecological associations. Of particular interest are those lakes, both large and small, with essentially forested watersheds. The growth usually is sparse enough to permit light penetration around the margins and, thus, growth of phytoplankton and aquatic plants.

---

[1] The settling of bottom land below the level of the Mississippi River following an earthquake in 1811 formed several lakes and sloughs in this area; among them the famous Reelfoot Lake system in Tennessee just below the Kentucky state line. Murphy's Pond, also noted for its abundance of aquatic life, is in this general area as well.

The region also contains numerous small lakes created by surface mining. These lakes can be found in all stages of recovery from acid mine drainage and coal washery pollutants. Some are quite viable as ecosystems and make an important contribution to the region's overall aquatic ecology. Examples of habitats of this nature may be found in the Green and Tradewater River systems in western Kentucky[1] (Figure 3-12, map numbers 5 and 4, respectively).

The largest lakes in the ORBES region are Lake Barkley and Kentucky Lake, Figure 3-12, map numbers 3 and 2, respectively. Both are included in calculations of regional indices as the Cumberland and Tennessee Rivers, and both are exceptionally valuable as natural areas. The Cumberland/Lake Barkley system is recorded as having 128 species, the record for the ORBES region, with the Tennessee/Kentucky Lake system close behind at 101. As noted in section 1.3, these lakes bound the famous wildlife and recreational area known as The Land Between The Lakes.

---

[1] The Weirs Marsh/Clear Creek system (Tradewater River drainage) and the Flat Creek/Pond River system (Green River drainage) are both important in this respect. These combined lake and wetland systems are in the vicinity of Madisonville, KY and, to some extent, are protected.

3.5 Slough and wetland ecosystems

Warm water sloughs containing mature cypress stands are prevalent in the western part of the ORBES region (see Figure 1-5). These sloughs are unique and are generally protected as wetlands and unique habitats. Along with some small tributaries, they contain some unique species and associations. Some mention of the Bayou de Chien/ Obion Creek area was made in Section 3.3. Similar areas occur along the lower Ohio River main stem up to the city of Henderson at mile point 828. These wildlife refuges are on the Mississippi flyway[1] and very important to the region.

In addition to the western ORBES region wetlands, there exist wetland valleys in the eastern mountains as well. One of the most important of these, and one which may ultimately be impacted by a pump-storage-project, is the Canaan Valley in West Virginia (see Figure 1-5). As of 1979 the U.S. Army Corps of Engineers has denied the permit for this facility on the grounds of the valley's merit as a wetland ecosystem.

---

[1] A major north/south migratory route for waterfowl.

The Canaan Valley is one of several Appalachian muskegs[1], possibly the largest, and represents a type of habitat unique in the entire ORBES region. The valley floor has an elevation of 3200 feet, covers about 25,000 acres, and during some summers has had frost every month. Many northern species of plants and animals reach the southern limits of their distribution here.

3.6 Existing regional aquatic ecosystem impacts

The existing conditions and protection levels of select ORBES streams are summarized in Table 3.5. As noted under conclusions in Section 1.5, all ORBES region navigable waterways and their major tributaries currently show violations of at least two of the 20 reference standards listed in Table 1-3. The Ohio River main stem shows violations for 11 of these standards under such conditions; phosphorus (as phosphate), iron, manganese, copper and chromium are the conservative agents most frequently found in violation with phosphorus exceeding the standard in every test stream in the region. The impact of these conditions on the existing aquatic biota must be considered before establishing 2000 AD scenario impacts.

---

[1] "Muskeg" is an Algonquin Indian word meaning trembling earth. The Canaan Valley is, in fact, a large sphagnum moss bog.

It is clear from the data given in Tables 3-5 and 1-4 that a prolonged drought in the region would result in stream nutrient and heavy metal concentrations harmful to some forms of aquatic life. Phosphates and nitrates fertilize aquatic environments just as effectively as terrestrial, if not more so. This results in higher levels of algal growth and, to some extent, in a more productive stream system.[1] The added number of algal cells tends to reduce light penetration, thus, discouraging growth of some aquatic plants; these same cells provide a biological source of oxygen and a food base for microscopic animals as well. If, as often happens, this supply of fertilizer becomes too abundant, then a eutrophic algal bloom occurs with subsequent depletion of dissolved oxygen during night phase metabolism, and also as a result of decay of moribund plant material. At present, the streams in the ORBES region appear to be in a state of balance in so far as eutrophication is concerned with

---

[1] Fish and wildlife departments often fertilize streams and lakes on purpose. Pennyrile Lake in Pennyrile State Park, KY is a recent (1976) example.

TABLE 3-5

EXISTING CONDITION AND PROTECTION LEVELS OF SELECT ORBES STREAMS

Stream Figure 1-2 Map Number	Protection Level	Name	Parameters in Violation of Reference Standards[1] at Low Flow Under Existing Conditions
36	A	Illinois River	NH_3, P, Cu, Fe, Pb, Mn, Hg
38	A	Big Muddy River	P, Fe, Mn
37	A	Kaskaskia River	P, Fe, Mn
25	B	Rock River	*********[2]
23	A	Mississippi River	P, Cu, Fe, Mn, Hg
54	B	White River	SUS, NH_3, P, Cu, Fe, Mn, Hg
41	A	Wabash River	SUS, P, Cu, Fe, Hg, Ni
10	A	Big Sandy River	SUS, Cr, P, Cu, Fe, Pb, Mn, Hg, Ni, B
7	A	Kentucky River	*********
6	A	Salt River	*********
3	A	Cumberland River	Cd, P, Ag, Fe, Mn, Hg

[1] For definition of reference standards see Section 1.5 and Table 1-4.

[2] See note 2 for Table 1-4.

nitrate levels limiting the process. (Notice that ammonia (NH_3), a nitrate precursor, shows up infrequently in Table 3-5). Some have, at times, come close to having true periods of eutrophic algal blooms, but to date, such happenings have been localized to a single system at a time.[1] Evidence does exist, however, to indicate that the consequences of eutrophication alone would be grave if prolonged drought were to extend over the entire region under today's conditions of stream loading and water consumption.

Table 3-6 provides a summary of projected impacts on the biota of selected ORBES waterways under conditions of persistent low flow. It becomes evident from the analysis condensed below which lead to these results that if such conditions extended to the entire region, the drought would have, in some instances, a devastating effect.[2]

---

[1] A serious incident of this nature occurred on the Salt River (Figure 1-2, map number 6) during a dry period in the summer of 1975.

[2] Extensive documentation of the impacts of heavy metal salts on fishes found in the ORBES is summarized in a separate document (6).

TABLE 3-6

SUMMARY OF PROJECTED IMPACT OF A PROLONGED DROUGHT ON SELECT ORBES STREAMS AND RIVERS UNDER EXISTING CONDITIONS

Figure 1-2 Map Number	Name	Initial Protection Level	Projected Impact	Resulting Protection Level
36	Illinois River	A	Severe	D
38	Big Muddy River	A	Minor	A
37	Kaskaskia River	A	Minor	A
25	Rock River	B	*****[1]	(B)[1]
23	Mississippi River	A	Minor	A
54	White River	B	Severe	D
41	Wabash River	A	Moderate	B
10	Big Sandy River	A	Severe	D
7	Kentucky River	A	*****[1]	(A)[1]
6	Salt River	A	*****[1]	(B)[1]
5	Green River	A	Moderate	B
8	Licking River	A	Moderate	B
17	Scioto River	A	Severe	D

---

[1] The recent water quality record (past 2 to 5 years) is limited for these streams under conditions of persistent low flow. Thus the estimates of impact are open to question.

TABLE 3-6 (continued)

SUMMARY OF PROJECTED IMPACT OF A PROLONGED DROUGHT ON SELECT ORBES STREAMS AND RIVERS UNDER EXISTING CONDITIONS

Figure 1-2 Map Number	Name	Initial Protection Level	Projected Impact	Resulting Protection Level
19	Muskingum River	B	Moderate	C
64	Whitewater River	B	Minor	B
15	Great Miami River	A	Moderate	C
16	Little Miami River	B	Moderate	D
70	Beaver River	B	Severe	D
69	Allegheny River	A	Moderate	C
67	Monongahela River	A	Moderate	B
71	Susquehana River		*****[1]	( )[1]
66	Kanawha River	A	Moderate	B
11-14	Ohio River	A	Severe	C

Temperature and dissolved oxygen profiles for the 1977 Ohio River main stem base case model urn (STREAM) are shown in Figure 1-6. The initial temperature for this run of 83°F was chosen because: (1) temperatures in the range of 83± 1°F are common during summer months in the upper Ohio, and (2) a temperature of 83°F is, in fact, in the range suggested by EPA as acceptable for the period June 16 - Auggust 31 (see Table 3-4). The model run indicates that at a minimum, violations of the temperature standards recommended by EPA for the Ohio River main stem should be anticipated at ten points during periods of prolonged drought under existing conditions. Of these ten points, all but two stay within 0.5°F and probably are of little consequence to the river's biota. The two points in more evident violation (85.7°F and 87.5°F)[1] occurred colse to each other and in the first 100 miles of the river. It must then be stated. based upon the EPA recommendations, that at or below these ten points the following would occur:

---

[1] These are temperatures the Ohio would reach at these points if the heated effluent in question were to be instantly moxed with the entire river flowing past its point of confluence. In actual fact, the temperatures along the bank below the outfall would be somewhat higher than 85.7°F (or 87.5°F) and those on the opposite shore somewhat lower.

(1) At or below the two points in evident violation smallmouth bass growth would be limited during the period June 1 - September 30; black crappie growth, channel catfish spawning and embryo survival for the emerald shiner and smallmouth buffalo would be limited during the period June 1-15; the growth of white crappie and white sucker would be adversely affected after September 1.

(2) Impacts at or below other eight points of violation would be minor consequence.

In actual fact, the Ohio River main stem normally reaches a temperature of 86°F in its lower reach in late summer; in other words, a temperature 2°F above the period average suggested by EPA (6).

The following conclusions concerning the impact of existing regional levels of stream loading and water consumption on the aquatic biota can be drawn for conditions of persistent low flow.

1. Impacts on the region's aquatic biota would vary from minor to severe depending upon land use patters around each specific waterway. The Illinois, White, Big Sandy, Scioto, Beaver and Ohio Rivers would all be severely impacted but each for different reasons in terms of pollutant source (for example, farming, mining, municipal waste or some unique combination of

these).

2. Temperature problems on the Ohio River main stem resulting from existing once-thru-cooling systems would be evident in only two locations. Impacts due to these heated effluents would be locally severe along the banks below the outfalls but their overall impact on the total river would be minor. Impacts on embryonic fishes due to toxic heavy metal salts being concentrated in the river would be much more serious.

3. It is probable that the region's only endangered fish species, the Scioto madtom (*Noturus trautmani*) would be lost under conditions of prolonged drought in the Scioto watershed. Available evidence indicates that this system would be particularly hard hit by high heavy metal salt concentrations and eutrophication.

Chapter 3

References

(1) Smith, Philip. The Fishes of Illinois. Urbana, Illinois: University of Illinois Press, 1979.

(2) Conant, R. Field Guide to Reptiles and Amphibians of Eastern North America. Houghton Mifflin Company, Boston, 1958.

(3) U.S. Department of the Interior, Threatened Wildlife of the United States (Washington, D.C., U.S. Government Printing Office, Resource Publication 114, 1973).

(4) Federal Register. 44 (1979) p. 3652.

(5) Doudoroff, P. and Shumway, D.L. Dissolved Oxygen Requirements of Freshwater Fishes. FAO Fisheries Technical Paper No. 86, Rome, Italy, 1970.

(6) Federal Register 44 (1979), p. 36255.

(7) Ohio River Valley Water Sanitation Commission, Data and Information in Response to U.S. EPA Federal Register Notice "Water Quality Standards; Main Stem of the Ohio River", Prepared by WAPORA, Inc., Cincinnati, Ohio for the ORSANCO Power Incustry Advisory Committee (Obtainable from ORSANCO, 414 E. Walnut Street, Cincinnati, Ohio, 45207; 1979).

Chapter 4.0 Water Impacts for Ohio River Basin Energy Study Scenarios

The ORBES study group considered a total of twenty-four scenarios for the year 2000 A.D. Water quality and aquatic ecology impacts were evaluated for ten of these as indicated in Table 4-1. In general, scenario results were superimposed upon the system(s) described in Chapters 1, 2 and 3, and the resulting impacts evaluated for conditions of 7-day, 10-year low flow.

Seven-day 10-year low-flow (7Q10) is a design parameter commonly used in river basin management and water quality assessments. It is the lowest flow of 7 days duration one can be sure will occur at least once every 10 years. Such numbers are specific for a given stream reach, and can be influenced by impoundment management above that reach as well as by land use in the immediate area. For example, (7Q10) at the McAlpine Lock and Dam on the Ohio River (mile point 606.8) in 1930 was projected to be 6000 cubic feet per second (CFS). This projection was based on the historical record available at the time, and upon knowledge of how impoundment releases in the basin above mile point 606.8 could be managed. The same projection for the same mile point today stands at 14,700 CFS, a figure better than double that of the 1930 value. In the interim many impoundments have been added to the basin and their influence on the projection is obvious.

TABLE 4-1

OHIO RIVER BASIN ENERGY STUDY SCENARIOS

BASIC DESCRIPTION OF SCENARIOS

Scenario Number[a]	Technology	Environmental Controls	Economic Growth
I. FOSSIL FUEL EMPHASIS			
①	conventional, coal emphasis	strict	high
1a	conventional, coal emphasis	very strict air quality, dispersed siting	high
1b	conventional, coal emphasis	very strict air quality, concentrated siting	high
1c	conventional, coal emphasis	strict agricultural lands protection, dispersed siting	high
1d	conventional, coal emphasis	strict agricultural lands protection, concentrated siting	high
②	conventional, coal emphasis	base case	high
(2a)	conventional, coal-fired exports	base case	high
2a1	conventional, coal-fired exports	base case, dispersed siting in western ORBES region	high
2a2	conventional, coal-fired exports	base case, plants on Ohio main stem with once-through cooling	high
2d	conventional, coal emphasis	lax (no compliance with SIP standards)	high
2e	conventional, coal emphasis	base case, 45-year plant life	high
2f	conventional, coal emphasis	base case, 25-year plant life	high

TABLE 4-1 (continued)

OHIO RIVER BASIN ENERGY STUDY SCENARIOS

Scenario Number[a]	Technology	Environmental Controls	Economic Growth
I. FOSSIL FUEL EMPHASIS			
2g	conventional, coal emphasis	base case	high (changes in energy demand growth)
2h	conventional, coal emphasis	base case	high (alternative coal prices)
2i	conventional, coal emphasis	base case, plants on Ohio main stem with once-through cooling	high
4	conventional, natural gas emphasis	base case	high
5	conventional, coal emphasis	base case	low
5a	conventional, coal emphasis	base case	very high
6	conventional, coal emphasis	base case	high (very low energy growth)
7	conventional, coal emphasis	base case	high (high electrical energy growth)
II. NUCLEAR FUEL EMPHASIS			
2b	conventional, nuclear-fueled exports	base case	high

TABLE 4-1 (continued)

OHIO RIVER BASIN ENERGY STUDY SCENARIOS

Scenario Number[a]	Technology	Environmental Controls	Economic Growth
II. **NUCLEAR FUEL EMPHASIS**			
2b1	conventional, nuclear-fueled exports	base case, plants on Ohio main stem with once-through cooling	high
(2c)	conventional, nuclear emphasis	base case	high
III. **ALTERNATIVE FUEL EMPHASIS**			
③	alternative	base case	high

[a] Scenarios circled are those for which water impacts were evaluated.

The ORBES study group responsible for water quality adopted 7Q10 as a worst case decision tool or parameter. Subsequently, an analysis was developed for the region in which water quality impacts were assessed reach by reach for each major stream in the system with each specific (7Q10) value being taken into account. At first glance it would appear that the assumption of region-wide (7Q10) conditions has been made, an event which is not likely to occur even under the most drastic of drought conditions. In fact, the assumption of (7Q10) conditions has been made only for individual watersheds in the system and nothing more. The impacts, for example, on the Kentucky River at (7Q10) would be the same regardless of what the flow happened to be in the Wabash River on the same day. As a rule, travel times on the region's major river systems at (7Q10) greatly exceeded 7 days making the analysis essentially reach specific. For example, travel time for the Ohio River mainstem at (7Q10) is 192 days.

The reader is cautioned against taking as the net impact of a given scenario the notion that all basin specific (7Q10) conditions would occur simultaneously. These impacts are considered basin specific and, with the obvious exception of a major receiving stream, may or may not occur in association with each other. For example, under a given scenario, the Big Sandy, Little Miami and the Great Miami might be said to be drastically impacted under (7Q10) conditions. This is not to be taken to indicate that these rivers would be so impacted simultaneously during the same 7 days during the same 10 year period. However, a period of (7Q10) along the entire length of the Ohio River would occur only if all of its tributaries dropped to (7Q10) as well. This indeed would be a truly drastic circumstance - somewhat beyond the usual thinking in support of worst case analysis.

The information flow for model input/output sequence and subsequent impact analysis for water quality and quantity is shown in Figure 4-1. The first step in the analysis was to take scenario siting patterns and then compute water consumption by all users with subsequent determination of the net effect on stream flows. Water quality in terms of solute concentrations were next determined for the stream and river systems listed in Table 1-1. Specific scenario effects are summarized in statistical tables organized in Appendix E.

4.1 Water Quality Impact Overview

Each scenario was run at three levels of power plant loading specified as 0%, 5%, and 100%. The water quality effects observed for 0% loading are those due to consumption only. These effects are noticeable on streams where existing backgrounds are already high. Under such circumstances, consumption alone causes the concentrations of solutes to exceed reference standards. At 5% loading it is presumed that effective measures for removal of pollutants from power plant effluents are taking place such that 95% of the utility loading existent today is removed. These measures take into

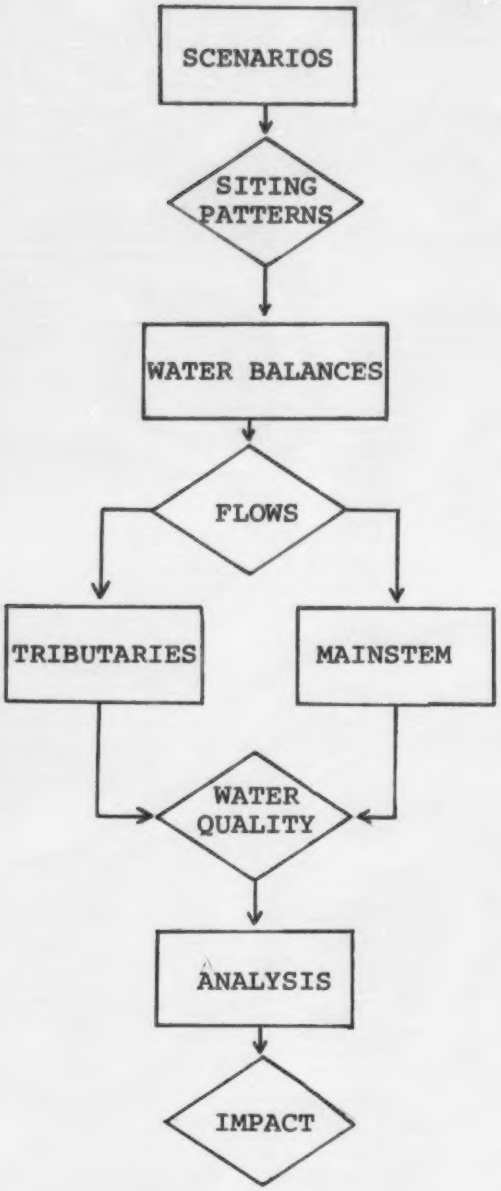

SCENARIOS
SITING PATTERNS
WATER BALANCES
FLOWS
TRIBUTARIES
MAINSTEM
WATER QUALITY
ANALYSIS
IMPACT

Figure 4.1 Information flow for scenario impact analysis

▭ models

◇ input-output

account updated plant design, new wastewater management practices, and the overall application of more stringent water pollution control laws than presently in force. At 100% loading it is presumed that the conditions of power plant design and operation are the same as today. The 100% loading concept is typical of lax environmental controls; 5% loading is typical of strict environmental controls.

Water consumption (and the subsequent concentrating of solutes) turned out to be a major factor in determining water quality effects. As a result, differences within scenarios due to the assignment of 0, 5, or 100% loading to power plants were at times small. These data are summarized in Table 4-2 from data in Appendix E.

On the average over all scenarios, the imposing of 5% loading over 0% caused a 34.7% increase in water quality events; the addition of 100% loading over 5% caused, in turn, a 78.2% increase in water quality events. These differences are statistically significant.[1] The proportion of water quality events due to consumption alone are summarized in Table 4-3 for the ten ORBES scenarios evaluated for water impacts. It is evident from these data that scenario 1 (strict environmental controls) is strikingly different from all the rest in terms of the portion of

---

[1] Comparison of the (0%-5%) and (5%-100%) event totals by a paired t-test results in (t) statistics of 13.44 and 23.67, respectively; both have 9 degrees of freedom and are significant at $p < 0.0005$.

TABLE 4-2

SUMMARY OF WATER QUALITY AND CONSUMPTION IMPACT EVENTS

Scenarios -- 0% loading assignment

Event[1]	1	2	2a	2b	2c	3	4	5	6	7
≥ 10% < 25%	29	25	31	30	26	21	19	24	17	36
≥ 25% < 50%	23	24	19	21	16	22	18	24	19	29
≥ 50%	52	32	37	36	27	27	23	30	21	73
Total	104	81	87	87	69	70	60	78	57	138

Scenarios - 5% loading assignment

	1	2	2a	2b	2c	3	4	5	6	7
≥ 10% < 25%	51	41	52	48	40	37	29	42	33	52
≥ 25% < 50%	26	23	20	26	23	23	22	23	19	35
≥ 50%	56	38	42	42	34	33	26	35	28	90
Total	133	102	114	116	97	93	77	100	80	177

Scenarios - 100% loading assignment

	1	2	2a	2b	2c	3	4	5	6	7
≥ 10% < 25%	70	58	53	56	47	58	55	52	44	49
≥ 25% < 50%	47	48	52	42	36	41	26	48	31	60
≥ 50%	115	91	87	95	89	85	70	83	80	173
Total	232	197	192	193	172	184	151	183	155	282

[1] Table 1-3 lists the reference standards used in the ORBES study to compare increments in ambient concentrations of constituents. These standards are based on current legal statutes but may not be exactly the same as state standards for a given river. Designations in the table are as follows: Blank - if overall stream reaches the maximum incremental concetration due to loading and consumption is < 10% of the reference standard in Table 1-3; 10 - if this incremental concentration is ≥ 10% of the standard but < 25%; 25 - if this incremental concentration is 25% of the standard but < 50% and; 50 - if this incremental concentration is ≥ 50% of the standard.

TABLE 4-3

PROPORTION OF WATER QUALITY EVENT[1] DUE TO WATER CONSUMPTION

	Scenarios[2]									
	1	2	2a	2b	2c	3	4	5	6	7
Percent[3]	78.2	41.2	45.3	45.1	40.1	38.0	39.7	42.6	36.7	48.9

---

[1] Water quality events are defined in Table 4-2 as the number of instances per scenario in which increments in ambient solute concentrations become ≥10% of their respective reference standards.

[2] Loading assignment for scenario (1) of 5%, all others 100%.

[3] Ratio of column totals from Table 4-2.

impact due to consumption alone. Given the same background of solutes in all cases.

The scenarios chosen for detailed study were scenario 1 at 5% loading assignment (strict environmental controls) and 2, 2a, 2b, 2c, 3, 4, 5, 6, and 7 at 100% loading assignment (lax environmental controls). Within this group only those comparisons involving a single descriptor are made; for example, as in coal emphasis versus nuclear emphasis with all else held constant. These are organized in Table 4-4 with notation of the richness of each comparison in terms of the percentage of total differences in water quality events observed out of those possible. Richness as so defined varied by over a factor of 10 with the strict versus lax environmental control scenarios (1 vs. 2) being the most different from each other, and high versus low economic growth (2 vs. 5) being nearly identical.

The following conclusions were drawn concerning the scenario water quality impacts in general:

1. Of the 24 streams selected for detailed study, all but three turned out to be scenario sensitive. The three that did not respond (scenario insensitive) were the Kaskaskia, Cumberland, and Salt Rivers; Figure 1-2 map numbers 37, 6, and 3, respectively.

2. The proportion of impact due to water consumption and subsequent concentrating of solutes was essentially uniform (average of 42.0%) for all scenarios having lax environmental controls. The same figure for the one

TABLE 4-4

SCENARIO RICHNESS FOR WATER QUALITY AND WATER CONSUMPTION EFFECTS

Scenario numbers[1]	Descriptors Compared	Percent Richness[2]
1 vs 2	Strict vs lax environmental controls	45.7
2 vs 7	Average energy growth vs NERC rates	39.8
2 vs 6	Average energy growth vs low growth rates	27.1
2 vs 2c	Coal emphasis vs nuclear emphasis	27.0
2 vs 4	Coal emphasis vs natural gas emphasis	15.7
2 vs 3	Coal emphasis vs alternatives emphasis	3.8
2 vs 2a	Coal emphasis vs coal exports	4.6
2c vs 2b	Nuclear emphasis vs nuclear exports	28.6
2c vs 2	Nuclear emphasis vs coal emphasis	27.0
2c vs 3	Nuclear emphasis vs alternatives emphasis	26.0
2c vs 4	Nuclear emphasis vs natural gas emphasis	25.2
2b vs 2a	Nuclear exports vs coal exports	4.6
2 vs 5	High vs low economic growth	3.3

---

[1] Loading assignment for scenario (1) of 5%, all others 100%.

[2] A total of 20 water quality/consumption variables were followed for 24 streams for each scenario. Three rivers (Figure 1-2, map numbers 3, 6 and 37) were scenario insensitive leaving 20 x 21 = 420 pssible differences.

scenario having strict environmental controls (scenario 1 at 5% loading) was 78.2%.

3. The loading assignments of 0, 5, and 100% corresponding to 100, 95 and 0% removal of existent power plant loading were found to be significant factors within scenarios. The imposing of 5% loading over 0% caused an average increase in water pollution events of 34.7%; the addition of 100% loading over 5% caused in turn a 78.2% increase in such events.

4. Plant consumption alone (effects at 0% loading) often led to cases where the concentration of a solute would increase to 10% and 25% of the reference standard. These increases were always large relative to the reference standards where the background concentrations were high to begin with. Under these circumstances the removal of even a small fraction of 7-day, 10-year low flow results in a water pollution event being recorded.

5. All scenarios showed significant levels of water quality and water consumption impacts. Scenario 1 (strict environmental controls) showed the least impact of the group, but was not without effects of its own. These were due to the dispersed siting pattern required to meet strict air pollution regulations which results in plants being sited on streams where flow was barely adequate. Subsequently, impacts in scenario 1 due to consumption alone were nearly double those due to consumption for the scenarios having lax

environmental controls.

6. In terms of water pollution events comparative scenario impacts were as follows:

Scenario 2 > 1 by 48.1%

7 > 2 by 43.0%
2 > 6 by 27.1%

2 > 2c by 14.5%
2 > 4 by 30.5%
2 > 3 by 7.0%
2 > 2a by 3.0%

2b > 2c by 12.0%
2 > 2c by 14.5%
3 > 2c by 7.0%
2c > 4 by 13.9%

2b > 2a by 0.5%

2 > 5 by 7.7%

Scenarios which differ by 10% or less are really not distinguishable in that slight adjustments in siting patterns would quickly erase any differences between them.

7. Scenario water quality impacts, although substantial in some cases, were not due in large measure to the power plants sited. Municipal and industrial consumption alone was in most cases sufficient to cause the registering of violations. The actual percentage increases in ambient concentrations of pollutants due to power plant consumption alone were, as a rule, small. The only exceptions to this occurred when power plants were sited on streams having barely sufficient flow for the plant demand.

4.2 Aquatic Ecology Impacts Overview

Four levels of water quality impact were used in developing an aquatic ecology assessment. These are designated in Tables F-1 through F-12 in Appendix F as a space if overall stream reaches the total of background plus incremental additions due to plant loading and consumption is less than or equal to the reference standard, "10" if this sum was $\geq$ 10% but $<$ 25% of the standard, "25" if this sum was $\geq$ 25% but $<$ 50% of the standard and "50" if this sum was $\geq$ 50% of the standard. There are several significant features of this method which relate directly to the development of the aquatic ecology assessment. The first has to do with the sensitivity of the biological systems in question to each parameter; the second concerns parameter concentrations at which maximum response occurs.

The 20 parameters listed in Table 1-3 are all to some degree toxic to biological systems. The actual toxicity of each would, of course, depend upon both the system in question and the levels of all other agents in its immediate environment. The complexity of this arrangement makes absolute specification of toxic levels of these components impossible. However, the reference standards listed in Table 1-3 are generally accepted legal (statute) values and thus reflect current knowledge as to relative toxicity. Mercury, for example, is assigned a statute value of 0.05 ug/l because of its high affinity for protein sulfhydryl groups and subsequent toxicity to biological systems in general. Iron, on the other hand, is less toxic and has a statue value of 0.30 mg/l -- fully

60,000 times higher than mercury. As a result the assignment of a "50" for mercury is more likely to occur than for iron in that it takes far less mercury to reach its standard or status value. In other words, the water quality events tabulated in Appendix F for a parameter under any given scenario occurred, or failed to occur, as a function of its toxicity to biological systems in general. Thus these "events" are weighted at the outset with respect to aquatic ecology impacts.

A second assumption implicit in this analysis is that organismal response to pollutants reach a maxima at some saturating concentration.[1] For the sake of being conservative, and since information giving precise saturating levels is lacking, the point at which increments plus ambient concentrations reach 50% or more of the reference standard was selected as the boundary condition for response maxima. Another way of stating this would be to say that we, as analyst, are just as concerned about totals reaching 50% of the reference standard as 100%, or 200%, given that "second kills" are meaningless. As a further precaution, and also in keeping with the notion of doing a "worst case" analysis, streams currently showing protection levels of A and B with existing high pollutant backgrounds were assumed to be subsisting at the threshold of degradation to lower protection levels.

---

[1] There is considerable theoretical justification for this assumption in that many of the enzyme systems upon which these organisms depend are characterized by saturating ligand concentrations at which maximum inhibition occurs.

The final step in the analysis was to develop a system to weight the water quality events listed in Appendix F. For this purpose the following equation was selected:

Water Quality Impact Index =

$$\frac{2(X_{50}) + 1(X_{25}) + 0.4(X_{10}) \quad 100}{40} .$$

where: X_{10}, X_{25} and X_{50} = observed number of events in which reference standards were exceeded by 10%, 25% and 50% or more.

In this analysis (X_{50}) events are assumed to be 2 times more harmful than (X_{25}) events and 5.0 times more harmful than (X_{10}) events. This provides a means of constructing tables which, at a glance, show the differences between scenarios in terms of expected aquatic impacts.

Table 4-5 to 4-16 gives the weighted events for 1976 7Q10 conditions and for the ten main ORBES scenarios. Four levels of impact(s) have been identified as corresponding to the percentages in Table 4-5 to 4-16. These are listed below:

Light -- Water Quality Impact Index 10%. Under these conditions impacts on a system's biota would likely not be detectable except locally in the vicinity of outfalls. No change in protection levels expected.

Moderate -- Water Quality Impact Index 10% 25%. Minor eutrophication with some loss of embryonic fishes existent at the time would be expected under these conditions. The effects would be noticeable at the time of low flow but recovery over the next several seasons would also be expected. One grade drop in protection level for the period of recovery.

Heavy -- Water Quality Impact Index 25% 50%. Eutrophication, the concentrating of heavy metal salts and possible stream dessication would be expected to combine to have a marked effect on the stream's biota. The effects would be noticeable immediately with possible local fish kills. A longer period of time, possibly 5 to 7 years, would be required for recovery. Two grade drops in protection level for a minimum of five years.

Drastic -- Water Quality Impact Index 50%. Eutrophication, heavy metal salts, dissolved oxygen depletion, siltation and stream dessication would all combine to essentially destroy the system existent at the time. Extensive fish kills would be expected all along the waterway with near complete loss of embryonic fishes. The period for recovery might range up to 20 years depending on the final condition of the watershed. Three grade drop in protection level for at least a 15 year period.

Table 4-5 Seven day - 10 year low-flow Impact for 1976

	Normal Flow 1976 Protection Levels	Better + Worse - Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	-	26	C	Heavy		
Beaver	A	-	30	C	Heavy		
Big Muddy	A	-	15	B	Moderate		
Big Sandy	A	-	39	C	Heavy		
Cumberland	A	-	30	C	Heavy		
Great Miami	A	-	47	C	Heavy		
Green	A	-	38	C	Heavy		
Illinois	A	-	15	B	Moderate		
Kanawha	A	-	31	C	Heavy		
Kaskaskia	A	0	15	B	Moderate		
Kentucky	A			I			
Licking	A	-	30	C	Heavy		
Little Miami	B	-	45	D	Heavy		
Mississippi	A	-	18	B	Moderate		
Monongahela	A	-	30	C	Heavy		
Muskingum	A	-	38	C	Heavy		
Ohio (main stem)		-	40	C	Heavy		
Rock	B			I			
Salt	A			I			
Scioto	A	-	35	C	Heavy		
Susquehanna	A			i			
Wabash	A	-	20	B	Moderate		
White	B	-	30	D	Heavy		
Whitewater	B			I			

Table 4-6 Base Case Compared to 1976

	Normal Flow 1976 Protection Levels	Better + Worse – Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	-	32	C	Heavy	E,P	7
Beaver	A	-	35	C	Heavy	E,M	3
Big Muddy	A	-	54	D	Drastic	E,P	0
Big Sandy	A	0	39	C	Heavy	E	0
Cumberland	A	0	30	C	Heavy	E	0
Great Miami	A	0	47	C	Heavy	E	0
Green	A	0	38	C	Heavy	E	0
Illinois	A	-	31	C	Heavy	P	8
Kanawha	A	-	34	C	Heavy	E,M	0
Kaskaskia	A	0	15	B	Moderate	E	0
Kentucky	A						0
Licking	A	0	30	C	Heavy	E	0
Little Miami	B	0	45	D	Heavy	E	0
Mississippi	A	0	18	B	Moderate	E	2
Monongahela	A	-	34	C	Heavy	E,M	3
Muskingum	A	-	40	C	Heavy	E,C	3
Ohio (main stem)	A	-	41	C	Heavy	E,M	72
Rock	B						2
Salt	A						0
Scioto	A	-	36	C	Heavy	E,M	2
Susquehanna	A						1
Wabash	A	-	22	B	Moderate	E,M	4
White	B	-	30	D	Heavy	E,M	0
Whitewater	B						0

Table 4-7 Strict Controls Compared to 1976

	Normal Flow 1976 Protection Levels	Better + Worse − Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	+	25	C	Heavy	E	11
Beaver	A	+	25	C	Heavy	E	0
Big Muddy	A	0	15	B	Moderate	E	0
Big Sandy	A	+	33	C	Heavy	E	1
Cumberland	A	+	25	C	Heavy	E	0
Great Miami	A	+	25	C	Heavy	E	1
Green	A	+	25	C	Heavy	E	0
Illinois	A	0	15	B	Moderate	E	3
Kanawha	A	+	25	C	Heavy	E	1
Kaskaskia	A	0	15	B	Moderate	E	0
Kentucky	A						
Licking	A	+	16	B	Moderate	E	0
Little Miami	B	+	41	D	Heavy	E	1
Mississippi	A	+	15	B	Moderate	E	2
Monongahela	A	+	25	C	Heavy	E	3
Muskingum	A	+	30	C	Heavy	E	0
Ohio (main stem)		+	33	C	Heavy	E	43
Rock	B						2
Salt	A						0
Scioto	A	+	25	C	Heavy	E	2
Susquehanna	A					E	1
Wabash	A	+	15	B	Moderate	E	6
White	B	+	15	C	Moderate	E	3
Whitewater	B						1

Table 4-8 Strict Controls Compared to Base Case

	Normal Flow 1976 Protection Levels	Better + Worse - Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	+	25				+4
Beaver	A	+	25				-3
Big Muddy	A	+	15	B	Moderate		
Big Sandy	A	+	33				+1
Cumberland	A	+	25				
Great Miami	A	+	25				+1
Green	A	+	25				
Illinois	A	+	15	B	Moderate	R	-5
Kanawha	A	+	25				+1
Kaskaskia	A	0	15				
Kentucky	A						
Licking	A	+	16	B	Moderate		
Little Miami	B	+	41				+1
Mississippi	A	+	15				
Monongahela	A	+	25				
Muskingum	A	+	30				-3
Ohio (main stem)		+	33				-29
Rock	B						
Salt	A						
Scioto	A	+	25				
Susquehanna	A						
Wabash	A	+	15	B	Moderate		+2
White	B	+	15	C	Moderate		+3
Whitewater	B						+1

Table 4-9 Base Compared to Coal-Fired Exports

	Normal Flow 1976 Protection Levels	Better + Worse – Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	-	34			P	+4 +1
Beaver	A	0					
Big Muddy	A	0					
Big Sandy	A	0					
Cumberland	A	0					
Great Miami	A	0					
Green	A	0					
Illinois	A	0					
Kanawha	A	0					
Kaskaskia	A	0					
Kentucky	A						
Licking	A	0					
Little Miami	B	0					
Mississippi	A	0					
Monongahela	A	0					
Muskingum	A	-	41			P	+2
Ohio (main stem)		0					+22
Rock	B						
Salt	A						
Scioto	A	-	40			P	+2
Susquehanna	A						
Wabash	A	0					
White	B	0					
Whitewater	B						

Table 4-10 Base Case Compared to Nuclear Fuel Exports

	Normal Flow 1976 Protection Levels	Better + Worse – Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	-	39				+4N
Beaver	A	0					
Big Muddy	A	0					
Big Sandy	A	0					
Cumberland	A	0					
Great Miami	A	0					
Green	A	0					
Illinois	A	0					+1N
Kanawha	A	0					
Kaskaskia	A	0					
Kentucky	A						
Licking	A	0					
Little Miami	B	0					
Mississippi	A	0					
Monongahela	A	-	40				+2N
Muskingum	A	0					
Ohio (main stem)		0					
Rock	B						
Salt	A						
Scioto	A	0					
Susquehanna	A						
Wabash	A	0					
White	B	0					
Whitewater	B						

Table 4-11 Base Case Compared to Nuclear Emphasis

	Normal Flow 1976 Protection Levels	Better + Worse – Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	+	31				-6C +1N
Beaver	A	+	30				-3C
Big Muddy	A	0					
Big Sandy	A	0					
Cumberland	A	0					
Great Miami	A	0					
Green	A	0					
Illinois	A	-	34				-8C +13N
Kanawha	A	0					
Kaskaskia	A	0					
Kentucky	A						
Licking	A	0					
Little Miami	B	0					
Mississippi	A	-	23				+5N
Monongahela	A	-	42				+2N
Muskingum	A	+	39				-2C
Ohio (main stem)		0					-7C +3N
Rock	B						-2C +2N
Salt	A						
Scioto	A	0					-2C
Susquehanna	A						-1C
Wabash	A	0					-2C +2N
White	B	0					
Whitewater	B						

Table 4-12 Base Case Compared to Alternative Fuel Emphasis

	Normal Flow 1976 Protection Levels	Better + Worse − Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	+	31				-2
Beaver	A	+	31				-2
Big Muddy	A	0					
Big Sandy	A	0					
Cumberland	A	0					
Great Miami	A	0					
Green	A	0					
Illinois	A	+	25				-3
Kanawha	A	0					
Kaskaskia	A	0					
Kentucky	A						
Licking	A	0					
Little Miami	B	0					
Mississippi	A	0					-1
Monongahela	A	0					
Muskingum	A	0					
Ohio (main stem)		0					-23
Rock	B						
Salt	A						
Scioto	A	0					-2
Susquehanna	A						
Wabash	A	0					
White	B	0					
Whitewater	B						

Table 4-13 Base Case Compared to Natural Gas Emphasis

	Normal Flow 1976 Protection Levels	Better + Worse – Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	+	29				-6
Beaver	A	+	30				-3
Big Muddy	A	0					
Big Sandy	A	0					
Cumberland	A	0					
Great Miami	A	0					
Green	A	0					
Illinois	A	+	25				-7
Kanawha	A	0					
Kaskaskia	A	0					
Kentucky	A						
Licking	A	0					
Little Miami	B	0					
Mississippi	A	0					
Monongahela	A	0					
Muskingum	A	+	39				-2
Ohio (main stem)		+	40				-47
Rock	B						-2
Salt	A						
Scioto	A	0					-2
Susquehanna	A						-1
Wabash	A	0					
White	B	0					
Whitewater	B						

Table 4-14 Base Case Compared to Coal Emphasis, Low Economic Growth

	Normal Flow 1976 Protection Levels	Better + Worse - Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	+	31				-2
Beaver	A	0					
Big Muddy	A	0					
Big Sandy	A	0					
Cumberland	A	0					
Great Miami	A	0					
Green	A	0					
Illinois	A	+	25				-3
Kanawha	A	0					
Kaskaskia	A	0					
Kentucky	A						
Licking	A	0					
Little Miami	B	0					
Mississippi	A	0					
Monongahela	A	0					
Muskingum	A	0					
Ohio (main stem)		0					-10
Rock	B						
Salt	A						
Scioto	A	0					-1
Susquehanna	A						-1
Wabash	A	0					
White	B	0					
Whitewater	B						

Table 4-15 Base Case Compared to High Economic Growth, Low Energy Growth

	Normal Flow 1976 Protection Levels	Better + Worse − Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due Mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	+	21				-7
Beaver	A	+	30				-3
Big Muddy	A	0					
Big Sandy	A	0					
Cumberland	A	0					
Great Miami	A						
Green	A	0					
Illinois	A	+	25				-8
Kanawha	A	0					
Kaskaskia	A	0					
Kentucky	A						
Licking	A	0					
Little Miami	B						
Mississippi	A	0					-1
Monongahela	A	0					-1
Muskingum	A	+	39				-2
Ohio (main stem)		+	40				-54
Rock	B						-2
Salt	A						
Scioto	A	0					-2
Susquehanna	A						-1
Wabash	A	+	20				-3
White	B						
Whitewater	B						

Table 4-16 Base Case Compared to High Economic Growth, and High Electrical Energy Growth

	Normal Flow 1976 Protection Levels	Better + Worse - Same 0	Water Quality Impact Index Range 0 - 100	Changed Protection Level	Changed Aquatic Habitat Impacts Under 1976 7-Q-10	Scenario Impact Due mainly to P,M,E,C,R	Number of Units Added
Allegheny	A	0					
Beaver	A	-	40				+1
Big Muddy	A	0					
Big Sandy	A	-	70	D	Drastic	P	+2
Cumberland	A	0					
Great Miami	A	-	58	D	Drastic	P	+4
Green	A	0					
Illinois	A	0					+1
Kanawha	A	-	35			P	+4
Kaskaskia	A	0					
Kentucky	A						+5
Licking	A	0					
Little Miami	B	-	65	D	Drastic	P	+2
Mississippi	A	0					
Monongahela	A	-	36			P	+1
Muskingum	A	-	41			P	+2
Ohio (main stem)		0					+14
Rock	B						
Salt	A						
Scioto	A	0					
Susquehanna	A						+1
Wabash	A	-	26			P	+2
White	B	-	32			P	+3
Whitewater	B						+2

4.3 Scenario 2i (once-through cooling on the Ohio Mainstem)

A once-through cooling variant of scenario 2 was also investigated. This scenario was designated as 2i and is discussed below. It differs from scenario 2 only in that plants along the Mississippi and the Ohio Mainstem are sited with once-through cooling instead of with cooling towers.

The efficiency of present day coal fired power plants (percentage of heat energy converted to electricity) is of the order of 38%. The balance of this heat is currently wasted to the environment either through evaporative cooling towers or by rejection directly to a receiving body of water. Heat rejection via cooling towers is dissipated by raising inlet water to its boiling point with subsequent vaporization. Heat rejection via once-through cooling comes about by raising the temperature of a large quantity of water (that flowing once through the plant) a small amount such that the receiving body will not be significantly affected (usually so that its temperature will be raised no more than $5^{\circ}F$). Currently there are 38 power plants along the Ohio Mainstem which reject heat directly to the river by the older once-through cooling method. The amount of heat released to the river by this method as of 1977 for these plants operating at 50% capacity was 1.23×10^{12} BTU/day. This is equivalent to the heat value of 51,600 tons of typical bituminous coal.

- o The retirement of old plants will reduce the amount of heat rejected through once-through cooling on the Ohio River Mainstem 11% by 1985 and 95% by 2000.
- o The removal of once-through cooling facilities (which will be essentially complete by 2000) will remove a thermal stress (heated effluent) from the river.

The terms, "water withdrawal" and "water consumption" must be clearly understood before further reviewing the topic of once-through versus cooling towers. Water consumed is that evaporated and thus lost completely from the system. Water withdrawn consists of that which is evaporated plus that which is returned to the river.

- o The amount of water lost from one mile of the Ohio River through natural evaporation on a typical summer day is equal to that which would be consumed by cooling towers fitted to a 1000 MW power plant.
- o A typical 650 MW coal-fired power plant running at 100% capacity requires a water withdrawal of 1020 cubic feet/second for once-through cooling. All of this is returned to the river as heated effluent. The same plant fitted with cooling towers requires a withdrawal of 19 cubic feet/second of which 13 cubic feet/second is consumed (evaporated). (The heated effluent from the once-through cooling plant also loses 7.5 cubic feet/

second by evaporation once it reaches the river).

- The amount of water withdrawn from the Ohio River Mainstem for cooling of power plants will be reduced 95% by 2000 if the replacement of once-through cooling by towers is completed as presently planned. Subsequently, loss of aquatic organisms (embryonic fishes, eggs, plankton) due to entrainment and impingement through power plant intake systems will be reduced 95%.

The question of heated effluent effects on net Ohio River temperature(s) is often raised with the view that power plants heat the total river to a significant degree. The following facts can be used to resolve this issue.

- River temperatures in late summer do indeed increase downstream going from an average of 83°F at the upper end to 86°F at the lower end. This rise can be completely accounted for as due to sunlight and would occur with or without power plants. The configuration of the river as a series of long narrow lakes (which are also shallow) is more important in terms of heat balance than power plant effluents.
- It is thermodynamically impossible for the power plants presently fitted with once-through cooling to do more than raise the temperature of the Ohio River locally. This they do with heated effluents that tend to slide along the surface and against the

banks where they come in. These effluents have a significant effect locally but dissipate within ten miles from their points of entry.

- It is also thermodynamically impossible for these power plants to melt a significant quantity of ice from a frozen Ohio River. The total heat rejected from a 650 MW plant operating at 50% capacity would, over a 24 hour period, melt less than a square mile of ice four inches thick.

In the scenario 2i 95 conjured 650 MW coal plants have been sited; 94 ultimately affect the Ohio River Mainstem and one is on the Susquehana. All new plants are assumed to use wet cooling towers except for those on the Ohio River Mainstem (60 plants) and the Mississippi (2 plants) which are assumed to have once-through cooling instead. Scenario 2i is otherwise identical to scenario 2.

Once-through cooling effects were evaluated using scenario adjusted flows and the computer models COLHEAT and STREAM. Conjured plants were sited along these rivers as single units (650 MW) or in groups of two units (1300 MW); heat rejection rates for these facilities operating at 50% capacity were 794,300 and 397,150 BTU/second, respectively.

As noted above, heated effluents skim along the surface of more dense (cooler) water and tend to hang along the banks below the outfall. Exact estimates of final temperatures at specific points below each outfall are impossible to make. However, some notion of what the maximum temperatures might can be obtained from the following equation:

$$\Delta t = \frac{\text{Heat Rejection Rate}}{(\text{Flow})\ (62.37)}$$

where t = degrees (°F) rise in temperature,

Heat Rejection Rate = 1222 BTU/(MW) (second),

Flow = flow considered as mixed with effluent in cubic feet/second,

Constant = 62.37 pounds of water/cubic feet at 60°F.

By way of example, if one takes 8000 cubic feet/second as the total flow in a reach and assumes it to be instantly mixed with effluent from a 1300 MW facility operating at 50% capacity, then the following Δt can be calculated:

$$\Delta t = \frac{(650)\ (1222)}{(8000)\ (62.37)} = 1.59^{\circ}F.$$

Obviously, the effluent mixes with less than the total river as it slides along the surface and against the bank. If one assumes mixing to take place in 25% of the total flow, then the calculation becomes:

$$\Delta t = \frac{(650)\ (1222)}{(2000)\ (62.37)} = 6.36^{\circ}F.$$

It can be seen from these calculations, as simple as they are, that for the Mississippi and the Ohio River total heating across from shore to shore is indeed of minor consequence in scenario 2i. This results from the choice of plant size, operating capacity, and recorded flow adjusted for scenario consumption. Much larger facilties (for example a 3000 MW plant operating at 70% capacity) would give better than a 5°F rise in temperature for a flow of 8000 cubic feet/second.

At the above flows and heat rejection rates, and assuming an initial river temperature of 83°F (which is typical of late summer), one can expect local violation of the 5°F rise limit along the banks of either river immediately below the effluent outfall at total river flows of 10,200 cubic feet/second or less (assuming mixing in 25% of total flow); violations of the 85°F maximum suggested for the Ohio River by US-EPA (Federal Register, Volume 144, Number 121, page 36255, June 21, 1979) can also be expected from shore to shore at flows of 6400 cubic feet/second or less.

The total amount of water withdrawn from the Mississippi and Ohio for power plant cooling of scenario plants operating at 50% capacity would be 6120 and 28,050 cubic feet/second, respectively; of this, 45 cubic feet/second would be lost by evaporation from the Mississippi (consumed) and 206 cubic feet/second from the Ohio.

The question of entrainment and impingement impact for once-through cooling, like that of thermal stress, is also one of a site specific nature. In the simplest of terms the fractional reduction in downriver organism population is given by the equation:

$$\text{Impact } (\%) = (Q_p/Q)\ (1-C_d/C_o)100$$

where Q_p = plant intake flow in cubic feet/second,

Q = river flow in cubic feet/second,

C_o = organism (embryonic fishes, eggs, phytoplankton) concentration at the intake (numbers per unit volume),

C_d = organism concentration in the plant effluent (numbers per unit volume).

The cropping rate of C_d/C_o is highly taxa specific. For some organisms, heat resistant algae for example, $C_d/C_o = 1.0$ and percent impact = 0.0%. For some embryonic fishes on the other hand, C_d/C_o and percent impact = (Q_p/Q) 100. The cropping ratio for a given taxa also varies with intake design and mode of operation. Entrainment and impingement must then be evaluated on both a site-by-site and taxa-by-taxa basis.

Taking the worst case $(C_d/C_o = 0)$ as the rule permits some analysis to be done for scenario 2i. Such as assumption gives the following results:

- The worst impact under scenario 2i due to entrainment and impingement would occur along the Ohio River Mainstem from mile points 70 to 772.
- These impacts range from a maximum of 16.2% reduction in sensitive species at mile point 70 to a 7.53% reduction below mile point 772.
- If the conditions of low flow observed during the spring-summer-fall of 1930 were to recur under scenario 2i entrainment and impingement alone could be expected to destroy 96.5% of the sensitive

organisms isolated below mile point 945 might be protected by flow from the Tennessee and Cumberland rivers during a prolonged drought (as in 1930).

Dissolved oxygen effects on the Ohio River Mainstem were evaluated for scenario 2i by use of the ORSANCO model STREAM with flows adjusted for scenario consumption rates. The initial conditions for the model run were temperature = 83°F and dissolved oxygen - 7.00 mg/liter at mile point 0.1.

- The model indicated a dissolved oxygen sag extending from mile point 5.2 to 84.2 with levels going to less than 4.00 mg/liter at its midpoint.
- Dissolved oxygen sags of a significant nature (dropping to levels of 5.00 mg/liter or less) were not indicated by the model below mile point 84.2.
- The model also indicated that dissolved oxygen levels would remain below saturation for the entire river under scenario 2i. Percent saturation ranged from 50% at mile point 31.7 to 97% at mile point 981.

Chapter 5.0 The Effects of Changes in Water Quality on Fish Distribution.

This chapter addresses changes in water quality which can be anticipated as a result of many of the activities associated with power production. Concern is often expressed that these changes will affect the distribution or vitality of fish species living in the receiving waters. Numerous attempts have been made to correlate the degree of change in water quality with changes in fish distribution or to provide models for these changes so that the changes may be predicted. Among these methods, the ones which are most useful for regional analyses are discussed here.

The chapter is divided into three sections: effects of non-conservative elements on fish distribution; the effects of conservative elements on fish distribution; and, a qualitative discussion of the effects of entrainment and impingement on fishes in the ORBES region.

5.1 Effects of non-conservative elements on fish distribution

Field measurements of certain water quality parameters traditionally accompany fish collections. These parameters include dissolved oxygen (DO), temperature and pH -- the non-conservative elements. Because of the abundance of information about the association of fish species with the non-conservative elements, various attempts have been made to correlate ranges or specific measurements of water quality with the distribution of fish species.

The literature resources of field and laboratory measures of the tolerance ranges of select fish species is abundant. However, agreement among the various reports is not common. This is expected since the effect of each water quality parameter on fish vitality is likewise affected by levels of other water quality parameters, both conservative and nonconservative.

The results of recent studies indicate that an attempt at correlation of water quality and fish distribution which is more general in nature may be the appropriate approach for a regional assessment. The report of Brungs and Jones (1) traces the history of the development of temperature criteria and offers a nomograph to determine the maximum weekly average temperature for heated effluent plumes at various ambient temperatures.

Subsequent to that discussion is the report of Doudoroff and Shumway (10) which proposes five acceptable minimum seasonal oxygen concentration ranges for five desired levels of fish protection. The problems associated with not only the different requirements of the various species but also the changing requirements at different life stages are also discussed.

The results of the third study are more specific than the first two. Cooper and Wagner (24) provide a list of several fish species and the minimum pH value of the stream in which they were collected. This study is also valuable for regional assessments.

The development of each of these three methodologies is discussed in the remainder of this section.

The literature resources concerning the effects of temperature changes on fish vitality is abundant. However, the major portion of the articles address the effects of temperature changes on select species of fish, generally of sport or commercial interest.

The design of experimentation in this area has been towards the goal of a definition of a lethal temperature for a given species. One approach to the solution of that problem utilizes controlled, _in vitro_, laboratory experimentation. Natural conditions, however, are not controlled conditions.

To remove the artificial conditions of such laboratory based experiments, field studies and observations have been recorded for various species. A comparison of results for any given species indicates that considerable variation exists for that species due to differences in environmental conditions, life stage of the fish, and general water quality.

In a report to the U.S. EPA, Brungs and Jones (1) have traced the development of temperature criteria for freshwater fishes. They have also included literature surveys and a summary of current information and practices regarding the impact of heated effluents on fish vitality. The compilation and analysis of information in this study lends itself well to regional studies such as ORBES. A condensation of their findings follows.

The Ohio River Valley Water Sanitation Commission (ORSANCO) Aquatic Life Advisory Committee in 1956 recommended the following concerning the temperature of receiving waters in the Ohio River Basin (2).

The temperature of the receiving water:

1) should not be raised above 34°C (93°F) at any place or at any time;
2) should not be raised above 23°C (73°F) at any place or at any time during the months of December through April; and
3) should not be raised in streams suitable for trout propagation.

This same committee in 1967 modified the recommendation of a temperature maximum of 34°C (93°F) to include the daily mean limit of 32°C (90°F). Brungs and Jones cite this improvement as "one of the first efforts to recognize the importance of both mean and maximum to describe temperature requirements of fishes." (1, p.2). The 1967 ORSANCO standards further included the following:

1) Maximum termperature during December, January, and February should be 55°F (12.8°C);
2) during the transition months of March, April, October and November the temperature can be changed gradually by not more than 7°F (3.9°C);
3) to maintain trout habitats, stream temperatures should not exceed 55°F (12.8°C) during the months of October through May, or exceed 68°F (20.0°C) during the months of June through September; and
4) insofar as possible the temperature should not be raised in streams used for natural propagation of trout.

Further milestones were reached in 1968 with the publication of the "Green Book," (3). This report on water quality criteria from the National Technical Advisory Committee of the Federal Water Pollution Control Administration recognized or recommended the following statements:

1) Organisms may be able to withstand elevated temperatures for short periods that would be fatal if extended for days.
2) Temperature requirements need to be somewhat specific for each body of water and fish population. Single values to apply throughout the United States are not acceptable.
3) Seasonal cycles must be maintained.

4) Temperatuare changes must be gradual.
5) The ultimate temperature attained must not change existing populations.

These changes documented the shift in emphasis to criteria based on site specific existing conditions. This same report advanced further by making suggestions, as summarized in tabular form in Table 5-1 from Brungs and Jones (1, p4), based on particular fish species.

Recommended water quality criteria from the Federal Water Pollution Control Administration (FWPCA) of 1969 for the Ohio mainstem were based on requirements of its important fishes. The 1969 Ohio River water criteria were significant in that they were species dependent and subsequently the criteria would probably be based upon a single species or a related group of species (1 p6). The 1970 ORSANCO temperature standards incorporated these recommendations.

The next significant advancement in the development of water temperature criteria was the issuance of the "Blue Book" in 1972. Officially known as Water Quality Criteria 1972 (4), the book is "the report of the Committee on Water Quality Criteria of the National Academy fo Sciences at the request of and funded by, the U.S. Envrionmental Protection Agency" (4, p8). The U.S. EPA followed the recommended approach of the Blue Book in their 1976 Quality Criteria for Water (5).

In their report, Burngs and Jones (1) included the heat and temperature section, recommendations, and appendix data from the Blue Book as authored by Dr. Charles Coutant. Information from that source will be included in the remainder of this discussion as it applies to the ORBES regional analysis.

TABLE 5-1

PROVISIONAL MAXIMUM TEMPERATURES RECOMMENDED AS COMPATIBLE WITH THE WELL-BEING OF VARIOUS SPECIES OF FISH AND THEIR ASSOCIATED BIOTA

93F: Growth of catfish, gar, white or yellow bass, spotted bass, buffalo, carpsucker, threadfin shad, and gizzard shad.

90F: Growth of largemouth bass, drum, bluegill, and crappie.

84F: Growth of pike, perch, walleye, smallmouth bass, and sauger.

80F: Spawning and egg development of catfish, buffalo, threadfin shad, and gizzard shad.

75F: Spawning and egg development of largemouth bass, white, yellow, and spotted bass.

68F: Growth or migration routes of salmonids and for egg development of perch and smallmouth bass.

55F: Spawning and egg development of salmon and trout (other than lake trout).

48F: Spawning and egg development of lake trout, walleye, northern pike, sauger, and Atlantic salmon.

A number of terms and phrases are used to describe the various limits on fish vitality(1). These terms are relevant to the differing environmental conditions and different life stages of the fish species.

Acclimation is an important concept that must be understood when addressing temperature effects on fish vitality. Though they are "cold-blooded" animals and by definition have body temperatures that fluctuate with the environmental temperatures, fish do need a period of time to adjust to these changes in temperature. This adjustment of bodily functions to a new temperature is acclimation and it is by no means an instantaneous process. Jones (7,p159) refers to a study (8) in which fathead minnows "took over 20 days to become completely acclimated to 16°C after previously living at 24°C, but became acclimated to 28°C from 20°C in 24 hours". He also found that lethal temperature of fish changed seasonally being higher in summer than winter. Thus single values for all fishes in all rivers is close to meaningless and even single values for a species throughout the year is not as good as one would hope, but significantly better than the former. However, the availability of such detailed information is lacking except in a few instances. Additional terms were defined as follows:

lethal threshold is the temperature at which 50% of a sample would survive indefinitely after acclimation to another temperature.

incipient lethal temperature is equivalent to the lethal threshhold.

upper incipient and lower incipient lethal temperatures are determined by removing the organisms from a temperature to which they are acclimated and instantly placing several of them in a series of other temperatures that will typically result in a range in survival from 100 to 0 percent.

ultimate upper incipient lethal temperature is the temperature beyond which no increase in lethal temperature is accomplished by further increases in acclimation temperature.

maximum weekly average temperature (*MWAT*) is the mathematical mean of multiple equally spaced daily temperatures over a seven day consecutive period.

MWAT for growth is calculated as the optimum temperature plus one-third of the differnce between the ultimate upper incipient lethal temperature and the optimum temperature.

MWAT for winter survival is the temperature which should not exceed the acclimation temperature (plume temperature) minus a 3.6°F or 2.0°C safety factor that raises the lower lethal threshold temperature above the normal ambient water temperature for that season.

short-term exposure to extreme temperature limit is the temperature to which fish can withstand a short exposure without significant adverse effects.

Values of these parameters for select fishes which occur in the ORBES region are given in Table 5-2.

The following abbreviations are used: MWAT for growth (MWAT-g), maximum temperature for short exposure (MSE), MWAT for spawning (MWAT-s), and maximum temperature for embryo survival (MES). The months listed are those in which spawning occurs. Temperatures are given in degrees centigrade with the equivalent Fahrenheit temperature in parentheses.

The MWAT for winter survival is designed to prevent fish deaths if the source of heated effluent ceases and fish are suddenly returned to ambient temperatures. Determination of MWAT values for the various species is facilitated by the availability of upper incipient lethal temperatures. It is more dificult to determine MWAT values for winter due to the less available lower incipient lethal temperatures. The information which was available was combined to produce the regression line shown in Figure 5-1. Rather than species specific information as was available for the other temperature parameters, the MWAT values for winter survival are generalized.

Information for all temperature parameters discussed above have a 2°C safety factor calcualted into the value. Without this safety factor, the calculations are for 50% survival; with the factor incorporated, there should be near 100% survival.

The current recommendation by ORSANCO is that the maximum temperature rise above ambient temperature may not exceed 5°F. The recommendation has been met with much concern by certain power service corporations who maintain that the requirement is much too stringent (9). For the purposes of the ORBES regional analysis the species specific values listed in Table 5-1 and the general values for winter conditions given in Figure 5-1 will be used.

The second of the non-consumptive parameters of water quality to be discussed, oxyben, is a requirement for the life of all multicellular organisms. In the aquatic habitat, oxygen is dissolved in the medium and is consumed by various oxidative processes. These include the metabolic activities of higher life forms, such as the fishes, as well as the invertegrate life forms which inhabit deep and surface sediments, and unoxidized pollutants such as sewage waste.

Within the sediments of an aquatic habitat, the dissolved oxygen (DO) is reduced by the oxidation of various chemicals which accumulate there. The DO concentration is often less

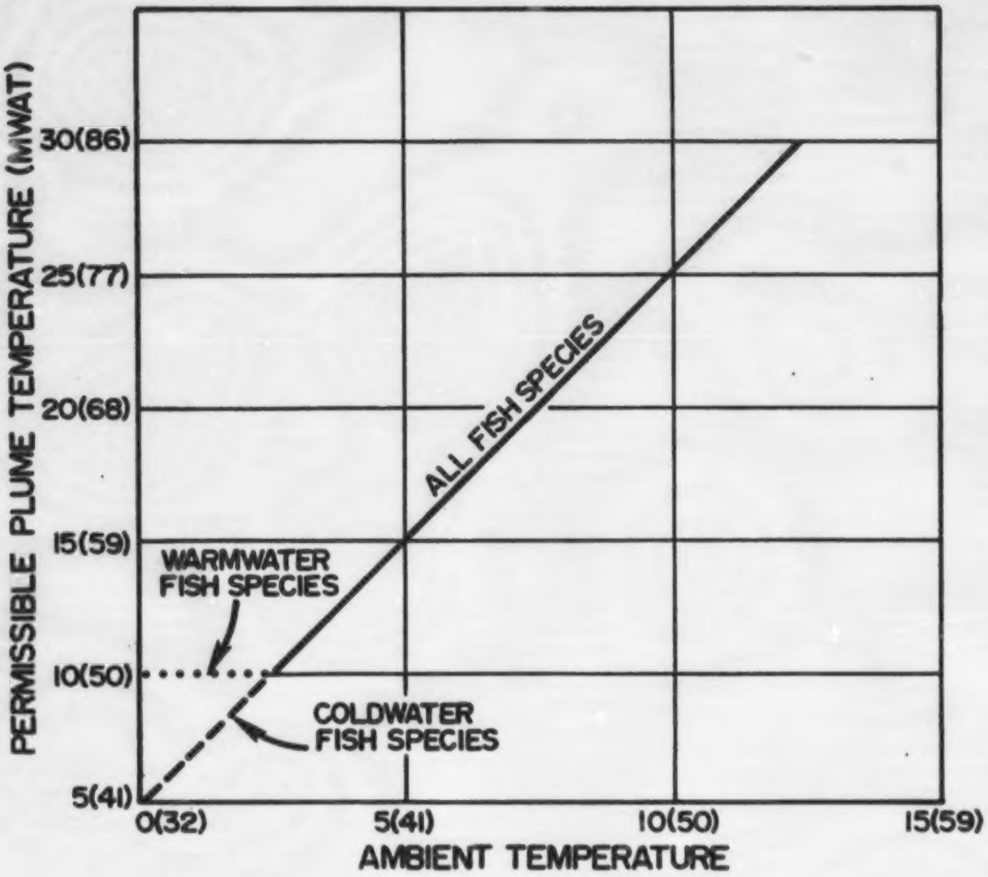
TABLE 5-2

TEMPERATURE PARAMETERS FOR FISHES IN THE ORBES REGION[1]

Species	MWAT-g	MSE	MWAT-s	Monthmonth	MES
Alewife	--	--	22(72)	Apr-Aug	28(82)
Bigmouth buffalo	--	--	17(63)	Apr-Jun	20(68)
Black crappie	27(81)	--	17(63)	Mar-Jul	20(68)
Bluegill	32(90)	35(95)	25(77)	Feb-Aug	34(93)
Brown bullhead	--	--76	24(75)	Mar-Sep	27(81)
Carp	--	--	21(70)	Mar-Aug	33(91)
Channel catfish	32(90)	35(95)	27(81)	Mar-Jul	29(84)
Emerald shiner	30(86)	--	24(75)	May-Aug	28(82)
Fathead minnow	--	--	24(75)	May-Aug	30(86)
Freshwater drum	--	--	21(70)	May-Aug	26(79)
Largemouth bass	32(90)	34(93)	21(70)	Apr-Jun	27(81)
Northern pike	28(82)	30(86)	11(52)	Feb-Jun	19(66)
Pumpkinseed	--	--	25(77)	May-Aug	29(84)
Sauger	25(77)	--	12(54)	Apr-Jun	18(64)
Smallmouth bass	--	--	17(63)	May-Jun	23(73)
Smallmouth buffalo	--	--	21(70)	Mar-Sep	28(82)
Striped bass	--	--	18(64)	Apr-Jun	24(75)
Threadfin shad	--	--	19(66)	Apr-Aug	34(93)
Walleye	25(77)	--	8(46)	Apr-May	17(63)
White bass	--	--	17(63)	Mar-Jun	26(79)
White crappie	28(82)	--	18(64)	Mar-Jul	23(73)
White sucker	28(82)	--	10(50)	Mar-Jun	20(68)
Yellow perch	29(84)	--	12(54)	Mar-Jun	20(68)

from Brungs and Jones (1)

[1] Temperatures are in °C (F).



Nomograph to determine the maximum weekly average temperature of plumes for various ambient temperatures, °C (°F).

FIGURE 5-1.
from Brungs and Jones (1)

in these sediments than it is at the water-sediment interface. If the sediments are perturbated, the chemical compounds which previously had been maintained in an anaerobic environment will be exposed to an environment where DO is available This often results in a decrease in DO as the sediment compounds become oxidized.

Oxygen is returned to the aquatic environment in various ways. These include photosynthetic activities, wind-waves at the surface and other activities which produce turbulence such as the propeller wash of barges and motorboats.

In order to support a viable aquatic ecosystem, a surplus of oxygen is required. That is, the amount of oxygen which is supplied to the aquatic system must be greater than the amount consumed. The effect of various levels of DO on fish at different stages of their life cycles, and the synergistic and antagonistic effect of fluctuating DO concentrations have been reported in the literature. The magnitude of surplus required for a diverse fish population has been the subject of numerous studies and are discussed here.

Constant low DO concentrations which are lethal to fish over a short period are reported as below 3.0 mg/liter for 29 species of fish under laboratory conditions (10). However, lethal concentrations for carp and rainbow trout are reported above 3.0 mg/liter under conditions of moderate temperature and long exposure (11).

The reduction of DO has an effect on spawning activity though the effect is varied. It may result in the prevention of spawning (10) or the results may be less pronounced. Siefert and Herman (12) found that reduction of DO resulted in earlier spawning activity of black crappie with indication of a correlation of the lower DO levels with earliest spawning activity.

Dissolved oxygen requirements for embryo development and hatching are varied also and differ for the various fish species. It has been reported that the embryos of certain fish species can develop at DO concentrations less than 2.0 mg/liter without apparent deleterious effects, though this is not the case for all (10). The embryos of largemouth bass, _Micropterus salmoides_ developed and hatched at DO concentrations from 1.0 to 1.3 mg/liter and temperatures from 15° to 25°C though the rate of survival was lessened significantly at concentrations below 2.0 - 2.8 mg/liter (13). DO concentrations above 4-5 mg/liter at normal temperature are required by embryos of sturgeon, pike, and fathead minnow for viable and normal development (10).

Young fish, because of higher metabolic rates and energy consumptive activities, are apparently more susceptible to decreased DO concentrations than older juveniles and adult fish. In studies with juvenile largemouth bass, DO concentrations of about 2 mg/liter and temperatures of 25°C, the fish reportedly grew and showed constant activity for 24 hours (10).

Changes in DO concentration affect general development and various behavior patterns as well. Feeding activities of fishes are reported to be affected variously by changes in DO. Under laboratory test conditions of restricted food and reduced DO levels, food conversion and growth of largemouth bass was reportedly not affected even to DO concentrations below 3 mg/liter (10). Other studies with juvenile largemouth bass indicate that any "considerable" variance of DO concentration from saturated conditions (except at low temperatures) resulted in diminished growth and feeding by these fish (14).

The growth of largemouth bass was restricted by wide fluctations in DO but abundant food supply. The effect was as if the fish had been constantly exposed to the lowest DO level (14). It thus appears that the ameliorative effects of adequate DO do not counteract the negative effects of low DO. Food consumption and growth of largemouth bass at low DO improved with decrease of temperature from 20 to 15°C. Thus, both cnages in DO concentration and changes in temperature with low DO affect the feeding behavior of certain fishes.

Reduction of the DO concentration to 5 mg/liter or less has been found to affect the maximum sustained swimming speed of certain freshwater fishes (16), (14). However, other research indicates that certain fishes can compensate for a lowering of DO concentration, within limits, by a reduction in activity (15).

Reduced DO concentrations can be of indirect detriment to fish populations in certain instances where the DO is not sufficient to cause death of fishes but does harm fish food organisms (10).

In addition to the various synergistic effects cited above, some long-term effects of fluctuating temperatures have been studied. If adult black crappie are exposed to constant and sufficient DO (2.5 mg/liter) during a simulated overwintering but are subjected to fluctuating diel concentrations during the simulated spring warm-up, the result can be inhibition of reproduction. The diel DO fluctuations were from 2.6 mg/liter to 1.8 mg/liter (16).

The effect of chronic exposure to low DO concentrations has also been investigated. Spawning activity was inhibited in fathead minnows when exposed to DO concentrations of 1 mg/liter for 11 months. At DO concentrations of 2 mg/liter, spawning activity was reduced. The larvae which did hatch under the latter conditions but did not survive beyond 2.5 days post-hatching. Similar reductions in vitality were reported when DO concentrations were held at concentrations below 4 mg/liter (17).

Several studies have been made of the effect of fluctuating DO concentrations on behavior and vitality of various fishes. No reproduction of black crappie occurred when DO concentrations fluctuated between 1.8 to 4.1 mg/liter and further behavioral changes occurred as the temperature was raised to 20°C (16). Abnormal behavior was recorded for bluegill, largemouth bass, and rock bass when diurnal DO concentrations fluctuated to 3 mg/liter (18), (19). If DO concentrations were reduced to 3.5 to 3.0 mg/liter during summer and to 2.0 mg/liter during winter, fishes of several species were killed within 48 hours (20). This pattern was observed under stream or lake conditions. Sudden exposure of largemouth bass, northern pike, and yellow perch to DO concentrations of 2.3, 2,3, and 1.5 mg/liter respectively, were lethal under winter conditions (21). Diurnal fluctuation of DO impaired the appetite and growth of certain fish at moderately high temperatures (10). If the temperature is reduced from $20^{\circ}$to 15°C, the feeding behavior and growth of largemouth bass under these conditions is improved (14). Thus, fluctuating concentrations of DO present stress conditions which are not totally alleviated when DO is at the higher concentration. A limiting minimum DO concentration must acknowledge these findings as well.

Doudoroff and Shumway (10) summarized much of the available literature concerning fish vitality and DO levels and presented it in tabular form. The survey was of the literature from 1937 to 1968 and the conditions of the various experiments are given as well.

Most of the experiments cited use death as the evaluative condition of the effect of the various DO concentrations. The allowable DO concentration then must be estimated as less than these amounts in order to prevent death. The imprecision of this practice in addition to the numberous findings of other than lethal effects at higher DO concentrations begs for an indicator other than death of the organism. Any decrease in DO below saturation will have an effect on the life sustaingin sustaining activities of the inhabitants of that aquatic environment. It is thus obvious that some indicator other than death must be found to establish where the limits should be set (10).

It is further noted that helpful as they may be, results of laboratory studies cannot be extrapolated as mirroring natural environmental conditions. Mindful of these problems and based upon literature surveys and their own studies, Doudoroff and Shumway (10) proposed the DO criteria presented in graphic form on the following page.

Plotting the estimated natural conditions against the "acceptable minimum DO" a series of curves were established. Curve A represents a 1:1 correlation and witnesses no change between the actual conditions and acceptable minimums. Curve B and B_1 represent conditions in which valuable fishery resources must be protected from any cause which may result in reduced fish production; B_1 conditions are those for major spawning grounds during months of spawning and hatching. Conditions in which Curve C apply include those in which fish resources are valuable but must coexist with industry or dense populations. Curve D is appropriate to conditions in which fish resources are somewhat less important in comparison to other uses which must be made of these waters.

This generalized diagram reduces the multitude of often conflicting reports to a useable form and the graph (Figure 5-1) presents the method of choice for regional impact analyses such as that of ORBES.

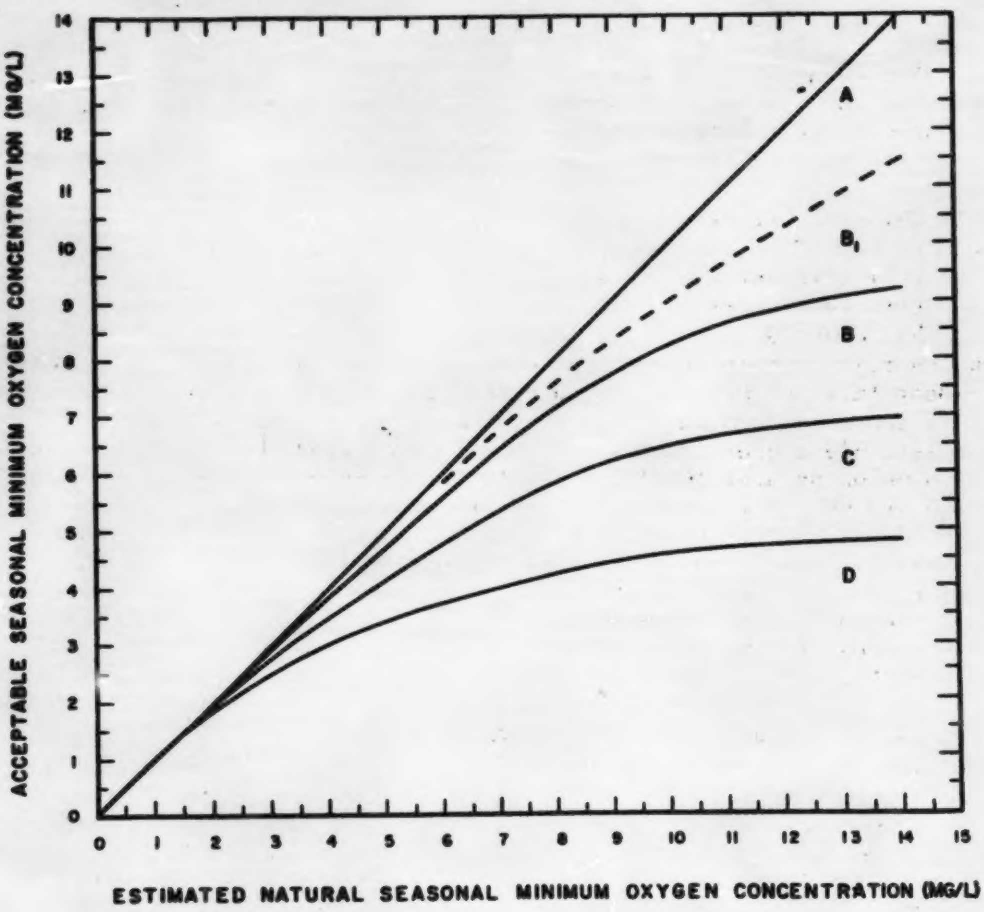


Figure 5 - 2

from Doudoroff and Shumway (10)

The third non-consumptive, water quality parameter is pH. Defined as the negative log of the hydrogen ion concentration, pH indicates the acid or basic nature of aqueous solutions. The range of values is from 0 to 14. A neutral solution is indicated by pH 7; acidic solutions have pH less than 7 and basic solutions have pH values greater than 7.

Two of the major sources of environmental pollutants which affect the pH of waterways of the ORBES region are acid mine runoff from coal mining and acid precipitation from sulfate aerosols. Both sources can affect the bota of waterways directly, by the action of pH or indirectly by increasing the solubility of metal ions.

The tolerance limits of pH on fish distribution have been extensively studied and recorded in the literature. Fewer attempts have been made to assess the effects of acid drainage on organisms under natural conditions rather than in the laboratory (22), (23), (24). The study by Cooper and Wagner (24) of teh effects of acid mine drainage on fish distribution in the stremas and rivers of Pennsylvania is an excellent source of information for studies of this type. From the field studies of the pH of various streams and rivers of Pennsylvania, a list was developed of fish species and the lowest pH of a strema where they were found. These lists are reproduced in Table 5-3.

The initial non-lethal condition caused by the decrease in pH is coagulation and precipitation of the surface mucus

TABLE 5-3

THRESHOLD LEVELS OF pH FOR FISH OCCURRENCE

Occurrence of fish species in waters having the indicated pH. The listing at each pH includes all previous species as well.

pH 4.5	No species recorded
pH 4.6	Chain pickerel Golden shiner White sucker Brown bullhead Pumpkinseed
pH 4.7	Creek chubsucker Largemouth bass
pH. 5.0	Brook trout
pH 5.2	Creek chub
pH 5.5	Yellow perch
pH 5.6	Bluntnose minnow Blacknose dace
pH 5.9	Brown trout Eastern mudminnow Longnose dace Margined madtom Tesselated darter Slimy sculpin
pH 6.0	Ohio lamprey Stoneroller Silverjaw minnow River chub Common shiner Silver shiner Rosyface shiner Mimic shiner Hog sucker Rock bass Smallmouth bass Greenside darter Fantail darter Johnny darter Banded darter Blackside darter
pH 6.2	Redfin pickerel Redbreast sunfish Rainbow darter Variegate darter Mottled sculpin
pH 6.4	American eel Redside dace Spotfin shiner Spottail shiner Pearl dace Bluespot sunfish Green sunfish

From Cooper and Wagner (24)

TABLE 5-3 (Cont.)

Fish never found at pH less than 6.5 (24).

Allegheny brook lamprey
Silver lamprey
Least brook lamprey
American brook lamprey
Spotted gar
Longnose gar
Bowfin
Bluegack herring
Alewife
American shad
Gizzard shad
Rainbow trout
Rainbow smelt
Central mudminnow
Northern pike
Muskellunge
Chain pickerel
Goldfish
Rosyside dace
Carp
Silvery minnow
Bigeye chub
Streamline chub
Silver chub
Horneyhead chub
Comely shiner
Satinfin shiner
Emerald shiner
Brindle shiner
Bigmouth shiner
Sand shiner
Southern redbelly dace
Brook stickleback
Warmouth
Bluegill
White crappie
Black crappie
Bluebreast darter
Spotted darter
Tippecanoe darter
Logperch
Channel darter
Longhead darter
Shield darter
Walleye
Freshwater drum
Brook silverside
Banded killifish
Burbot
Trout perch
Flathead catfish
Tadpole madtom
Stonecat
Channel catfish
Yellow bullhead
Black bullhead
White catfish
Shorthead redhorse
Golden redhorse
Silver redhorse
Longnose sucker
Quillback
Fathead minnow

layer of gills. The lethal condition occurs if the actual gill tissue is coagulated (25).

A decrease in pH can affect aquatic organisms in an indirect way as well. Lowering the pH increases the solubility of toxic metal ions and makes them more available to aquatic life forms. If great enough quantities of the metal ions are ingested, the fish population suffers stress, illness, or death. Variations in pH will also affect the solubility of gases dissolved in the water (25). Invertebrates and aquatic plants are food sources for many of the fishes and thus the indirect effect may be depletion of a food source before or during the occasion of the direct effect of the toxic gases.

5.2 Effect of conservative elements on fish distribution.

Much research has been conducted to document the direct effect of conservative agents, for example stable metal ions and their associated salts, on fish vitality. The results of some of this research as it applies to fish species found in the ORBES region is presented in Table 5-4. Only the effects of those metal ions discussed in the ORBES baseline document, section 4.1.3.2.1-1 were used.

With few exceptions, the toxic threshold to the species indicated are above the standards. The exceptions are the effects of cadmium on reproductive system of trout; the maximum acceptable concentration of cadmium to the fathead minnow; the impaired performance of goldfish at 0.1% of the lethal concentration of lead; the hatchability of the fathead minnow eggs at the indicated concentration of nickel; and the LC_{50} of nickel for trout.

The discrepancy between the lethal threshold or the LC_{50} of the metla ions for various species and the quoted standards should not be interpreted as reason for raising the standards. Most tests were performed to study the effects of a single ion on fish vitality. The synergistic effects of certain combinations of ions are dramatic and greatly increase the toxicity of an ion. For example, when fathead minnows were tested in water of 200 mg/l hardness, a lethal threshold of copper, cadmium, and zinc was reached when the metals were at concentrations of 0.4 or less of the lethal threshold of the individual element (33). In this instance, the standards for all three metals are greater than the lethal concentrations cited. Other environmental variables such as pH, hardness and dissolved oxygen can affect the toxicity of a given element on the vitality of fishes. The research available concerning such synergistic effects is small.

5.3 Entrainment and impingement

When water is removed from the environment to condense steam back to liquid in the power generating process, and when the water is then returned to the environment, there is potential danger to fish resources. If fish eggs or small fishes are taken into the cooling system, they are said to be entrained. If on the other hand, the fish are not taken into the condenser system,but are caught against the intake screens,they are impinged.

TABLE 5-4

WATER QUALITY STANDARDS AND LEVELS OF FISH TOLERANCE

Factor	Ref. Stan. mg/1	Fish	Reason	Ref.
TDS	500	Striped bass	Eggs surviving salinity greater than 1000 mg/1 TDS greatly reduced if eggs were not water hardened.	26
TSS	50	Various	Reduced light penetration; gill injury; reduction of food supply; fouling of spawning beds.	47
SO_4	250			37
NH_3	1.1		Estimated lethal limit at about 2.5 ppm for pH values between 7.4 and 8.5	
As	0.05	Goldfish	Impaired performance at 1/100th the lethal concentration.	35
		Goldfish	LC_{50} of arsenic = 0.49 ppm	49
Ba	1.0			27
Cd	0.01	Brook trout	Abnormally vascularized and discolored testes at 25 ug/1 for 24 hours; LC_{50} = 10 mg/1 in continuous flow for 21 days.	
		Fathead minnow	Maximum acceptable toxicant concentration = 37-57 ug/1.	44
		Bluegill	LC_{50} lethal at 80 ug/1 with 200 mg/1 hardness; progeny killed at 90 ug/1; larvae crippled when adult spawned at 239 ug/1 and 2140 ug/1.	42
		Trout	LC_{50} = 13 ppm.	34
		Fathead minnow	lethal threshold of Cu, Cd, Zn mixture = 0.4 the individual lethal level	26
		Goldfish	0.17 ppm = LC_{50}	33
Cl	250			27

TABLE 5-4 (cont.)

Factor	Ref. Stan. mg/1	Fish	Reason	Ref.
Cr	0.01	Largemouth bass	LC_{50} of hexavalent chromium = 195 mg/1.	36
			LC_0 = 48.4, LC_{50} = 113, LC_{100} = 176 mg/1.	30
		Trout	LC_{50} = 0.16 - 0.20 ppm	26
		Goldfish	0.66 ppm = LC_{50}.	27
PO_4	0.05			
Se	0.01	Goldfish	Impaired performance at 1% of lethal conc.	49
		Goldfish	LC_{50} = 4.18 ppm for embryo and larvae	27
Ag	0.005	Largemouth bass and bluegill	Exposure to 0.3 to 70 ug/1 resulted in accumulation	32
		Trout	LC_{50} = 0.01 ppm	26
		Goldfish	0.03 ppm = LC_{50}	27
Cu	0.06	Bluegill	96 hour LC_{50} = 2.4 mg/1. No alteration in oxygen consumption at 0.1 mg/1.	40
		Brook trout	No adversity of second generation at 9.4, 6.1, or 4.5 ug/1.	37
			Maximum acceptable concentration with hardness at 45 mg/1, pH 7.5 is 9.5 to 17.4 ug/1	38
		Fathead minnow	Lethal threshold of Cu, Cd, Zn, mixture = 0.4 of the individual lethal threshold.	33
			LC_0 = 0.75; LC_{50} = 1.25; LC_{100} = 2.10 mg/1	30
		Trout	LC_{50} = 0.09 ppm	26
Fe	0.30	Fathead minnow	Safe level of suspended iron is between control and 1.5 mg/1.	46
		Brook trout	Sudden decline in growth at 12, 25 and 50 mg/1.	47
Pb	0.05	Goldfish	Impaired performance at .0.1% of lethal concentration.	49

TABLE 5-4 (cont.)

Factor	Ref. Stan. mg/1	Fish	Reason	Ref.
Pb	Trout	Trout	LC_{50} = 0.16 - 0.20 ppm	26
		Goldfish	1.66 ppm is the LC_{50}	26
Mn	0.05			
Hg (ug/1)	0.05	Goldfish	Feeding behavior affected at 10 and 6 ug/1	43
			48 hour, LC_{50} = 0.5 - 1.0 mg/1; 5 mg/1 fatal in 10 hours.	37
			Measurable effects at 0.003 mg/1	49
		Trout	LC_{50} value 0.005 ppm	26
		Rainbow trout	0.1 ppb = 100% embryonic mortality	27
		Goldfish	0.12 ppm = LC_{50}	27
Ni	1.0	Fathead minnow	No adversity at 0.38 mg/1; significant reduction in number and hatchability of eggs at 0.73 mg/1.	41
		Trout	LC_{50} = 0.05 ppm	26
Zn	0.205	Rainbow trout	Indicated acute inflammatory reaction in gill tissue at 40 mg/1 Zn^{++}	45
		Bluegill	Sublethal concentration = 5.6 mg/1	28
			0.25 mg/1 inhibited spawning and killed newly hatched fry.	31
			At pH 5.7 - 7.0, 13 mg/1 = 100% mortality	29
		Fathead minnow	Lethal threshold ov Cu, Cd, Zn mixture is 0.4 of the individual lethal level.	33
			LC_0 = 2.4; LC_{50} = 4.2; LC_{100} = 5.9 mg/1	30
Bo	1.0	Rainbow trout	0.001 - 0.1 ppm = LC_1 from fertilization through 4 days post hatching.	27
		Goldfish	0.2 - 1.4 ppm = LC_1 from fertilization to 4 days post hatching	27
		Channel catfish	0.2 to 5.5 ppm = LC_1 from fertilization to 4 days post hatching	27

Any prediction in this study of the effects of entrainment and impingement on the fish resources of the ORBES region msut be qualitative. The literature which addresses the quantitative effects of entrainment and impingement is most abundant. However, as is the case for the non-conservative elements of water quality discussed earlier, the information is addressed to specific sites in most instances.

The location of water intake structures and the site of effluent release can be in potential conflict with spawning areas and habitats of immature fishes. The report of the 1978 Ohio River Ecological Research Program by WAPORA, Inc. to the American Electric Power Service Corporation (50) lists Ohio River mainstem species and particulars of their spawning and breeding requirements. This data base provides a basis from which qualitative estimates can be made of the anticipated effects of once-through cooling and accompaning entrainment and impingement. Additionally the classification of the species as isolated, limited, distributed, or ubiquitous (discussed in chapter 3) is used to indicate potential impact on the region.

We first examine potential problems associated with unprotected intake pipes. If a fish species deposits eggs in a manner of broadcasting or if the young swim free and are not protected by the adult fish, in these instances, the eggs or young fish could be swept into the intake of the condenser system and suffer the stresses associated with entrainment. These stresses include heat, mechanical agitation, and possible exposure to biocides. Table 5-5 presents the fishes which

TABLE 5-5 FISHES POTENTIALLY IMPACTED AT WATER INTAKE

Fish species (regional classification)	Broadcast egg deposition	Free-swiming young
Paddlefish (D) *Polyodon spathula*	X	X
Longnose gar (D) *Lepisosteus osseus*	X	
Alewife (L) *Alosa pseudoharengus*	X	
Gizzard shad (U) *Dorosoma cepedianum*	X	X
Threadfin shad (L) *Dorosoma petenense*		X
Goldeye (D) *Hiodon alosoides*	X	X
Redfin pickerel (D) *Esox americanus americanus*	X	
Muskellunge (L) *Esox masquinongy*	X	
Goldfish (D) *Carassius auratis*	X	X
Carp (U) *Cyprinus carpio*	X	X
Speckled chub (D) *Hybopsis aestivalis*	X	X
Silver chub (D) *Hybopsis storeriana*	X	
Golden shiner (D) *Notemigonus crysoleucas*	X	X
Emerald shiner (D) *Notropis atherinoides*	X	X
Sand shiner (D) *Notropis stramineus*	X	X
Mimic shiner (U) *Notropis volucellus*	X	
River carpsucker *Carpiodes carpio*	X	

TABLE 5-5 (cont.)

Fish species (regional classification)	Broadcast egg deposition	Free-swimming young
Quillback carpsucker (U) Carpiodes cyprinus	X	
White sucker (U) Catostomus commersoni	X	X
Northern hog sucker (D) HHypentelium nigricans	X	X
Smallmouth buffalo (D) Ictiobus cyprinellus	X	X
Spotted sucker (D) Minytrema melanops		X
Black redhorse (D) Moxostoma duquesni	X	X
Golden redhorse (U) Moxostoma erythrurum	X	
Shorthead redhorse (D) Moxostoma macrolepidotum	X	
Channel catfish (U) Ictalurus punctatus		X
Brook silverside (D) Labidesthes sicculus		X
White bass (D) Morone chrysops	X	X
Green sunfish (U) Lepomis cyanellus		X
Bluegill (U) Lepomis macrochirus		X
Spotted bass (D) Micropterus punctulatus		X
Largemouth bass (U) Micropterus salmoides		X
White crappie (U) Pomoxis annularis		X
Eastern sand darter(D) Ammocrypta pellucida		X

TABLE 5-5 (cont.)

Fish species (regional classification)	Broadcast egg deposition	Free-swimming young
Yellow perch (D) *Perca flavescens*	X	X
Logperch (D) *Percina caprodes*	X	X
River darter (D) *Percina shumardi*		X
Sauger (D) *Stizostedion canadense*	X	X
Walleye (D) *Stizostedion vitreum*	X	X
Freshwater drum (D) *Aplodinotus grunniens*		X

would be subject to the problems at the intake pipe, the regional classification and reason for inclusion.

After passing through the condenser, warm water along with any entrained material is released back to the aquatic environment. It is at this point where the most sensitive environment can be affected. Shorelines of large streams and rivers are of extreme importance to fish resources. Many species deposit eggs in the vegetation or debris in the quiet waters along the banks. Quite often the young fish will seek protection in these areas as well. Table 5-6presents a listing of species which deposti eggs in vegetated areas or in riverine margined areas and the young of those species which continue to inhabit bank habitats after hatching. The potential exists for the released heated effluents to scour these banks or to change the water temperature relations there.

TABLE 5-6 RIVER BANK USES BY FISHES.

Fish species (regional classification)	Eggs deposited near banks	Young fish inhabit banks
Longnose gar (D) *Lepisosteus osseus*	X	X
Alewife (L) *Alosa pseudoharengus*	X	X
Gizzard shad (U) *Dorosoma cepedianum*	X	
Threadfin shad (L) *Dorosoma petenense*	X	X
Goldeye (D) *Hiodon alosoides*	X	
Redfin pickerel (D) *Esox americanus americanus*	X	X
Muskellunge (L) *Esox masquinongy*	X	X
Goldfish (D) *Carassius auratis*	X	
Carp (U) *Cyprinus carpio*	X	
Silver chub(D) *Hybopsis storeriana*	X	
Golden shiner (D) *Notemigonus crysoleucas*	X	X
Emerald shiner (D) *Notropis atherinoides*		X
Rosyface shiner (D) *Notropis rubellus*	X	
Sand shiner (D) *Notropis stramineus*	X	
Mimic shiner (U) *Notropis volucellus*	X	
Steelcolor shiner (D) *Notropis whipplei*	X	
Bluntnose minnow (U) Pimephales notatus	X	

TABLE 5-6 (cont.)

Fish species (regional classification)	Eggs deposited near banks	Young fish inhabit banks
Fathead minnow (D) *Pimephales promelas*	X	
Smallmouth buffalo (D) *Ictiobus cyprinellus*	X	
Silver redhorse (D) *Moxostoma anisurum*	X	
River redhorse (D) *Moxostoma carinatum*		X
Shorthead redhorse (D) *Moxostoma macrolepidotum*	X	
Black bullhead (U) *Ictalurus melas*	X	
Yellow bullhead (U) *Ictalurus natalis*	X	X
Brown bullhead (D) *Ictalurus nebulosus*	X	X
Channel catfish (U) *Ictalurus punctatus*	X	
Flathead catfish (D) *Pylodictis olivarius*	X	
Trout-perch (D) *Percopis omiscomaycus*		X
Brook silverside (D) *Labidesthes sicculus*	X	X
White bass (D) *Morone chrysops*	X	X
Rock bass (U) *Ambloplites rupestris*	X	X
Pumpkinseed (D) *Lepomis gibbosus*	X	X
Warmouth (D) *Lepomis gulosus*	X	X
Bluegill (U) *Lepomis macrochirus*	X	

TABLE 5-6 (cont.)

Fish species (regional classification)	Eggs deposited near banks	Young fish inhabit banks
Longear sunfish (U) *Lepomis megalotis*	X	X
Redear sunfish (D) *Lepomis microlophus*	X	X
Smallmouth bass (U) *Micropterus dolomieui*	X	X
White crappie (U) *Pomoxis annularis*	X	X
Black crappie (D) *Pomoxis nigromaculatus*	X	X
Greenside darter (D) *Etheostoma blennoides*	X	X
Rainbow darter (D) *Etheostoma caeruleum*	X	
Fantail darter (D) *Etheostoma flabellare*		X
Johnny darter (U) *Etheostoma nigrum*	X	
Banded darter (D) *Etheostoma zonale*	X	
Yellow perch (D) *Perca flavescens*	X	
River darter (D) *Percina shumardi*		X
Sauger (D) *Stizostedion canadense*		X
Walleye (D) *Stizostedion vitreum*	X	
Mottled sculpin (D) *Cottus bairdi*	X	

References for Chapter 5

① (1) Brungs, W. A. and Jones, B. R. 1977. Temperature Criteria for Freshwater Fish: Protocol and Procedures. EPA-600/3-77-061. Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency.

(2) Ohio River Valley Water Sanitation Commission (ORSANCO). Aquatic Life Advisory Committee, 1956. Aquatic life water quality criteria — second progress report. Sew. Ind. Wastes 28:678-690. As cited in Brungs and Jones 1977 — 1967. Aquatic life water quality criteria — fourth progress report. Env. Sci. Tech. 1:888-897. As cited in Brungs and Jones 1977.

(3) Federal Water Pollution Control Administration, National Technical Advisory Committee. 1968. Water Quality Criteria. U.S. Department of the Interior, Washington, D.C., 245 p.. As cited in Brungs and Jones, 1977.

(4) Federal Water Pollution Control Administration. 1969 a. FWPCA Presentations ORSANCO Engineering Committee. U.S. Department of the Interior, Sixty-Ninth Meeting, Cincinnati, Ohio (May 13-14, 1969). As cited in Brungs and Jones 1977.

(5) National Academy of Sciences and National Academy of Engineering (NAS/NAE). 1973. Water Quality Criteria 1972. A Report of the Committee on Water Quality Criteria. U.S. Environmental Protection Agency Pub. No. EPA - R3 - 73 - 033. Washington, D.C., 553 p. (as cited in Brungs and Jones 1977).

(6) U.S. Environmental Protection Agency. 1976. Quality Criteria for Water. Office of Water and Hazardous Materials. Washington, D.C.. EPA 440/9-76-023, 501 p.. As cited in Brungs and Jones, 1977.

(7) Jones, J.R.E. 1964. Fish and River Pollution. Washington: Butterworth and Co. Publishers, 203 p..

(8) Brett, J.R. 1940. Some lethal temperature relations of Algonquin Park fishes. University of Toronto Studies in Biology, 52 (1944) 49pp..

(9) See the Aquatic Ecology Baseline Data document for the basis of this argument.

(10) Doudoroff, P. and Shumway, D. L.. 1970. Dissolved Oxygen Requirements of Freshwater Fishes. FAO Fisheries Technical Paper No. 86. FIRI/T86.

(11) Downing, K. M. and Merkens, J. C.. 1957. The Influence of Temperature on the Survival of Several Species of Fish in Low Tensions of Dissolved Oxygen. Ann. Appl. Biol. 45(2):261-267. As cited in Doudoroff and Shumway, 1970.

(12) Siefert, R. E. and Herman, L. J.. 1977. Spawning Success of the Black Crappie *Pomoxis nigromaculatus* at Reduced Dissolved Oxygen Concentrations. Trans. Am. Fish. Soc. 106:376-378. As cited in Carlson and Herman 1978.

(13) Dudley, R. G. and Eipper, A. W. 1975. Survival of Largemouth Bass Embryos at Low Dissolved Oxygen Concentration. Trans. Am. Fish. Soc. 104(1)122-128. As cited in Doudoroff and Shumway.

(14) Warren, C. E., Doudoroff, P., and Shumway, D. L.. 1973. Development of Dissolved Oxygen Criteria for Freshwater Fish. EPA-R3-73-091.

(15) Lagler, K. F., Bardach, J. E., and Miller, R. R.. 1962. Ichthyology. John Wiley and Sons, Inc., New York.

(16) Carlson, A. R. and Herman, H. J.. 1978. Effect of Long-Term Reduction and Diel Fluctuation in Dissolved Oxygen on Spawning of Black Crappie, *Pomoxis nigromaculatus*. Trans. Am. Fish. Soc., 107(5): 742-746.

(17) Brungs, W. A.. 1971. Chronic Effects of Low Dissolved Oxygen Concentrations on the Fathead Minnow *Pimephales promelas*. J. Fish. Res. Board Can. 28:1119-1123. As cited in Carlson and Herman, 1978.

(18) Bouck, G. R. and Ball, R. C.. 1965. Influence of a Diurnal Oxygen Pulse on Fish Serum Proteins. Trans. Am. Fish. Soc. 94:363-370. As cited in Carlson and Herman, 1978.

19) Bouck, G. R.. 1972. Effects of Diurnal Hypoxia on Electrophoretic Protein Fractions and Other Health Parameters of Rock Bass *Ambloplites rupestris*. Trans. Am. Fish. Soc. 101:448-493. As cited in Carlson and Herman 1978.

(20) Ellis, M. M., Westfall, B. A., Meyer, D. K. and Platner, W. S.. 1947. Water Quality Studies on the Delaware River with Reference to Shad Migration. *Spec. Scient. Rep. U.S. Fish Wildl. Serv. Fisheries*. No. 38, 19p.. As cited in Doudoroff and Shumway 1970.

(21) Moore, W. G.. 1942. Field Studies on the Oxygen Requirements of Certain Freshwater Fishes. Ecology 23:319-29. As cited in Jones(1964).

(22) Parsons, J. D., 1968. The Effects of Acid Strip-Mine Effluents on the Ecology of a Stream. Archives Hydrobiology 65 (1) 25-50.

(23) Leuthart, C. A. 1975. Reclamation of Orphan Strip Mined Land in Southern Illinois and Western Kentucky: A Field Study of the Palzo Project of Williamson County, Illinois and the Clear Creek Swamp of Webster and Hopkins Counties, Kentucky. Unpublished Dissertation, University of Louisville, Louisville, Kentucky.

(24) Cooper, E. L. and C. C. Wagner. 1973. The Effects of Acid Mine Drainage on Fish Populations. In. Fish and Food Organisms in Acid Mine Waters of Pennsylvania. EPA - R3-73-032. U. S. Environmental Protection Agency. Washington, D.C..

(25) Jones, J. R. E. 1964. Fish and River Pollution. Butterworth and Co. Publishers, Washington 203 p..

(26) Birge, W. 1977. Aquatic Toxicology of Trace Elements of Coal and Fly Ash. Pre-print of a paper presented at the Ecological Symposium on Energy and Environmental Stress in Aquatic Systems. Sponsored by: Savannah River Ecology Laboratory, et. al..

(27) Birge, W. J., J. A. Black, and A. G. Westerman. 1977. Evaluation of Aquatic Pollutants Using Fish and Amphibian Eggs as Bioassay Organisms. Paper presented at the International Symposium on Pathobiology of Environmental Pollutants-Animal Models and Wildlife as Monitors. Storrs, Conn..

(28) Burton, D. T., E. L. Morgan, J. Cairns, Jr. 1972. Mortality Curves of Bluegills (Lepomis macrochirus) simultaneously exposed to temperature and zinc stress. Trans. Amer. Fish Soc. 101(3):435-441.

(29) Cairns, J., Jr., T. K. Bahns, D. T. Burton, K. L. Dickson, R. E. Sparks, and W. T. Waller. 1972. The Effects of pH, Solubility and Temperature upon the toxicity of Zn to Bluegill Sunfish. Trans. Kans. Acad. Sci. 74(1):81-92.

(30) Cairns, J., Jr. and A. Scheier. 1968. A Comparison of the Toxicity of Some Common Industrial Waste Components Tested Individually and Combined. Progr. Fish-Culturist 30(1): 3-8.

(31) Cairns, J., Jr., and R. E. Sparks. 1971. The Use of Bluegills to Detect Zinc. U.S. E.P.A. Rep. 18050 EDQ: 1-45.

(32) Coleman, R. L. and J. E. Cearley. 1974. Silver Toxicity and Accumulation in Largemouth Bass and Bluegill. Bull. Environ. Contam. Toxicol. 12(1): 53-61.

(33) Eaton, J. G.. 1973. Chronic Toxicity of a Copper, Cadmium, and Zinc Mixture to the Fathead Minnow (Pimephales promelas) Water Research 7(11): 1723-1736.

(34) Eaton, J. G.. 1974. Chronic Cadmium Toxicity to the Bluegill Lepomis macrochirus. Trans. Amer. Fish Soc. 103(4): 729-735.

(35) Ellis, M. W.. 1937. Detection and Measurement of Stream Pollution. Bull. U.S. Bur. Fish 48: 365-437.

(36) Fromm, P. O. and R. H. Schiffman. 1958. Toxic Action of Hexavalent Chromium on Largemouth Bass. Jour. Wild. Manag. 22(1): 40-44.

(37) Haga, Y., H. Haga, T. Hagino, and T. Kariya. 1970. Studies on the Post-Mortem Identification of the Pollutant in the Fish Killed by Water Pollution III. Acute poisoning with mercury (1). Bull. Jap. Soc. Sci. Fish 36(3): 225-231.

(38) McKim, J. M. and D. A. Benoit. 1971. Effects of Long-Term Exposure to Copper on Survival, Growth, and Reproduction of Brook Trout (Salvelinus fontinalis) Jour. Fish Res. Bd. Can. 28: 655-662.

(39) McKim, J. M. and D. A. Benoit. 1974. Duration of Toxicity Tests for Establishing "No Effect" Concentrations for Cu with Brook Trout (Salvelinus fontinalis). Jour. Fish. Res. Bd. Canada 31: 449-452.

(40) O'Hara, J. 1971. Alterations in Oxygen Consumption by Bluegills Exposed to Sublethal Treatment with Copper. Water Res. 5: 321.327.

(41) Pickering, Q. H.. 1974. Chronic Toxicity of Nickel to the Fathead Minnow. Jour Wat. Poll. Contr. Fed. 46 (4): 760-765.

(42) Pickering, Q. H. and M. H. Gast. 1972. Acute and Chronic Toxicity of Cadmium to the Fathead Minnow (Pimephales promelas). Jour. Fish. Res. Bd. Can. 29(8): 1099-1106.

(43) Salzinger, K., S. P. Fairhurst, S. J. Freimark, and F. D. Wolkoff. 1973. Behavior of the Goldfish as an Early Warning System for the Presence of Pollutants in Water. Jour. Enviro. Sys. 3(1): 27-40.

(44) Sangalong, G. B. and M. J. O'Halloran. 1972. Cadmium-Induced Testicular Injury and Alterations of Androgen Synthesis in Brook Trout. Nature 240 (5382): 470-471.

(45) Skidmore, J. F. and P. W. A. Tovell. 1972. Toxic Effects of Zinc Sulfate on the Gills of Rainbow Trout. Water Res. 6(3): 217-230.

(46) Smith, E. J., J. L. Sykora, and M. A. Shapiro. 1973. Effect of Lime Neutralized Iron Hydroxide Suspension on Survival, Growth, and Reproduction of the Fathead Minnow (Pimephales promelas). Jour. Fish Res. Bd. Canada 30: 1147-1153.

(47) Sykora, J. L., E. J. Smith, and M. Synak. 1972. Effect of Lime in Neutralized Iron Hydroxide Suspension on Juvenile Brook Trout Salvelinus fontinalis. Water Research 6(8): 935-950.

(48) Turner, J. L. and T. C. Farley. 1971. Effects of Temperature, Salinity, and Dissolved Oxygen on the Survival of Striped Bass Eggs and Larvae. Calif. Fish and Game 57(4): 268-273.

(49) Weir, P. A. and C. H. Hine. 1970. Effects of Various Metals on Behavior of Conditioned Goldfish. Arch. Environ. Health 20(1): 45-51.

(50) WAPORA, Inc., 1978. 1978 Ohio River Ecological Research Program. Appendix. Prepared by Dr. Margulies and Orville Burck of WAPORA, Inc., 5700 Hillside Ave., Cincinnati, Ohio, 45233.

APPENDIX A

A SYSTEMATIC LISTING OF THE FISHES
OF THE ORBES REGION

Super Class: AGNATHA
Class: PETROMYZONES
Order: PETROMYZONTIFORMES
Family: PETROMYZONTIDAE
Genus: Ichthomyzon

Ichthyomyzon bdellium (Jordan) Ohio lamprey
Ichthyomyzon castaneus (Girard) Chestnut lamprey
Ichthyomyzon fossor (Reighard & Cummins) Northern brook lamprey
Ichthyomyzon greeleyi (Hubbs & Trautman) Allegheny brook lamprey
Ichthyomyzon unicuspis (Hubbs & Trautman) Silver lamprey

Genus: LAMPETRA
Lampetra aegyptera (Abbott) Least brook lamprey
Lampetra lamottei (LeSueur) American brook lamprey

Super Class: GNATHOSTOMATA
Class: OSTEICHTHYES
Order: ACIPENSERIFORMES
Family: ACIPENSERIDAE
Genus: ACIPENSER
Acipenser fulvescens (Rafinesque) Lake sturgeon

Genus: SCAPHIRHYNCHUS
Scaphirhynchus albus (Forbes & Richardson) Pallid sturgeon
Scaphirhynchus platorynchus (Rafinesque) Shovelnose sturgeon

Family: POLYONDONTIDAE
Genus: POLYODON
Polyodon spathula (Walbaum) Paddlefish

Order: AMIIFORMES
Family: AMIIDAE
Genus: Amia
Amia calva (Linnaeus) Bowfin

Order: LEPISOSTEIFORMES
Family: LEPISOSTEIDAE
Genus: LEPISOSTEUS
Lepisosteus oculatus (Winchell) Spotted gar
Lepisosteus osseus (Linnaeus) Longnose gar
Lepisosteus platostomus (Rafinesque) Shortnose gar
Lepisosteus spatula (Lacepede) Alligator gar

Order: CLUPEIFORMES
Family: CLUPEIDAE
Genus: ALOSA
Alosa alabamae (Jordan & Evermann) Alabama shad
Alosa chrysochloris (Rafinesque) Skipjack herring
Alosa pseudoharengus (Wilson) Alewife

Genus: DOROSOMA
Dorosoma cepedianum (LeSueur) Gizzard shad
Dorosoma petense (Gunther) Threadfin shad

Family: SALMONIDAE
Genus: SALMO
Salmo gairdneri (Richardson) Rainbow trout
Salmo trutta (Linnaeus) Brown trout
Genus: SALVELINUS
Salvelinus fontinalis (Mitchill) Brook trout

Family: OSMERIDAE
Genus: OSMERUS
Osmerus mordax (Mitchill) American smelt

Family: UMBRIDAE
Genus: ESOX
Esox americanus americanus Redfin pickerel
Esox americanus vermiculatus (LeSueur) Grass pickerel
Esox lucius (Linnaeus) Northern pike
Esox masquinongy (Mitchill) Muskellunge
Esox niger (LeSueur) Chain pickerel

Family: HIODONTIDAE
Genus: HIODON
Hiodon alosoides (Rafinesque) Goldeye
Hiodon tergius (LeSueur) Mooneye

Order: CYPRINIFORMES
Family: CATOSTOMIDAE
Genus: CYCLEPTUS
Cyleptus elongatus (LeSueur) Blue sucker

Genus: ICTIOBUS
Ictiobus bulbalus (Rafinesque) Smallmouth buffalo
Ictiobus cyprinellus (Valenciennes) Bigmouth buffalo
Ictiobus niger (Rafinewque) River carpsucker

Genus: CARPIODES
Carpiodes carpio (Rafinesque) River carpsucker
Carpiodes cyprinus (LeSueur) Quillback
Carpiodes velifer (Rafinesque) Highfin carpsucker

Genus: CATOSTOMUS
Catostomus catostomus (Forster) Longnose sucker
Catastomus commersoni (Lacepede) White sucker

Genus: HYPENTELIUM
Hypentelium nigricans (LeSueur) Northern hog sucker

Genus: ERIMYZON
Erimyzon oblongus (Mitchill) Creek chubsucker
Erimyzon sucetta (Lacepede) Lake chubsucker

Genus: MINYTREMA
Minytrema melanops (Rafinesque) Spotted sucker

Genus: MOXOSTOMA

Moxostoma anisurum (Rafinesque) Silver redhorse

Moxostoma atripinne (Bailey) Blackfin sucker

Moxostoma aureolum (LeSueur) Northern redhorse

Moxostoma breviceps Ohio redhorse

Moxostoma carinatum (Cope) River redhorse

Moxostoma duquesni (LeSueur) Black redhorse

Moxostoma erythrurum (Rafinesque) Golden redhorse

Moxostoma macrolepidotum breviceps (Cope) Southern shorthead redhorse

Moxostoma macrolepidotum macrolepidotum Northern shorthead redhorse

Moxostoma rhothroecum Torrent sucker

Moxostoma rubreques Greater redhorse

Genus: CYPRINUS

Cyprinus carpio (Linnaeus) Carp

Genus: CTENOPHARYNGODON

Ctenopharyngodon idella (Valenciennes) Grass Carp

Genus: CARASSIUS

Carassius auratus (Linnaeus) Goldfish

Genus: CHROSOMUS

Chrosomus erythrogaster (Rafinesque) Redbelly dace

Chrosomus oreas Mountain redbelly dace

Genus: CLINOSTOMUS

Clinostomus elongatus (Kirtland) Redside dace

Clinostomus funduloides (Girard) Rosyside dace

Clinostomus vandoisulus Rosy dace

Genus: NOTEMIGONUS

Notemigonus crysoleucas (Mitchill) Golden shiner

Genus: SEMOTILUS

Semotilus atromaculatus (Mitchill) Creek chub

Semotilus margarita Pearl dace

Genus: PAREXOGLOSSUM

Parexoglossum laurae hubbsi (Trautman) Western tonguetied chub

Genus: RHINICHTHYS

Rhinichthys atratulus (Hermann) Blacknose dace

Rhinichthys cataractae (Valenciennes) Longnose dace

Genus: NOCOMIS

Nocomis biguttatus (Kirtland) Hornyhead chub

Nocomis effusus (Lachner & Jenkins) Redtail chub

Nocomis leptocephalus Bluehead chub

Nocomis micropogon (Cope) River chub

Nocomis platyrhynchus Bigmouth chub

Genus: HYBOPSIS

Hybopsis aestivalis (Girard) Speckled chub

Hybopsis amblops (Rafinesque) Bigeye chub

Hybopsis biguttata Horneyhead chub

Hybopsis dissimilis (Kirtland) Streamline chub

Hybopsis gelida (Girard) Sturgeon chub

Hybopsis gracilis (Richardson) Flathead chub

Hybopsis insignis (Hubbs & Crowe) Blotched chub

Hybopsis meeki (Jordan & Everman) Sicklefin chub

Hybopsis micropogon River chub

Hybopsis storeriana (Kirtland) Silver chub

Hybopsis x-punctata (Hubbs & Crowe) Gravel chub

Genus: NOTROPIS

Notropis albeolus
Notropis amnis (Hubbs & Greene) Pallid shiner
Notropis ardens (Cope) Rosefin shiner
Notropis ariommus (Cope) Popeye shiner
Notropis atherinoides (Rafinesque) Emerald shiner
Notropis blennius (Girard) River shiner
Notropis boops (Gilbert) Bigeye shiner
Notropis buchanani (Meek) Ghost shiner
Notropis camurus Bluntface shiner
Notropis cerasinus
Notropis chalybaeus (Cope) Ironcolor shiner
Notropis coccogenis (Cope) Warpaint shiner
Notropis cornutus chrysocephalus (Rafinesque) Central common shiner
Notropis deliciosus stramineus Northeastern sand shiner
Notropis dorsalis (Agassizi) Bigmouth shiner
Notropis emiliae (Hay) Pugnose minnow
Notropis fumeus (Everman) Ribbon shiner
Notropis galacturus (Cope) Whitetail shiner
Notropis heterolepis (Eigenmann & Eigenmann) Blacknose shiner
Notropis hudsonius (Clinton) Spottail shiner
Notropis leucidus (Cope) Tennessee shiner
Notropis lutrensis (Baird & Girard) Red shiner
Notropis maculatus (Hay) Taillight shiner
Notropis photogenis (Cope) Silver shiner
Notropis procne Swallowtail shiner
Notropis rubellus (Agassizi) Rosyface shiner
Notropis rubricroceus
Notropis scabriceps New River shiner
Notropis shumardi (Girard) Silverband shiner
Notropis spilopterus (Cope) Spotfin shiner
Notropis stramineus (Cope) Sand shiner
Notropis telescopus (Cope) Telescope shiner
Notropis texanus (Girard) Weed shiner
Notropis umbratilis (Girard) Weed shiner
Notropis venustus (Girard) Blacktail shiner
Notropis volucellus (Cope) Mimic shiner
Notropis whipplei (Girard) Steelcolor shiner

Genus: PHENACOBIUS

Phenacobius mirabilis (Girard) Suckermouth minnow
Phenacobius teretulus Kanawha minnow
Phenacobius uranops (Cope) Stargazing minnow

Genus: PIMEPHALES

Pimephales notatus (Rafinesque) Bluntnose minnow
Pimephales promelas (Rafinesque) Fathead minnow
Pimephales vigilax (Baird & Girard) Bullhead minnow

Genus: DIONDA

Dionda nubila (Forbes) Ozark minnow

Genus: NYBOGNATHUS

Hybognathus argyritis (Girard) Western silver minnow
Hybognathus hankinsoni (Hubbs) Brassy minnow

Hybognathus hayi (Jordan) Cypress minnow
Hybognathus nuchalis (Agassizi) Silvery minnow
Hybognathus placitus (Girard) Plains minnow

Genus: ERICYMBA
Ericymba buccata (Cope) Silverjaw minnow

Genus: CAMPOSTOMA
Campostoma anomalum (Rafinesque) Stoneroller
Campostoma oligolepis (Hubbs & Greene) Largescale stoneroller

Family: ICTALURIDAE
Genus: ICTALURUS
Ictalurus catus (Linnaeus) White catfish
Ictalurus furcatus (LeSueur) Bluecatfish
Ictalurus melas (Rafinesque) Black bullhead
Ictalurus natalis (LeSueur) Brown bullhead
Ictalurus punctatus (Rafinesque) Channel catfish

Genus: PYLODICTUS
Pylodictus olivaris (Rafinesque) Flathead catfish

Genus: NOTURUS
Noturus elegans (Taylor) Elegant madtom
Noturus eleutherus (Jordan) Mountain madtom
Noturus exilis (Nelson) Slender madtom
Noturus flavus (Rafinesque) Stonecat
Noturus furiosus Northern madtom
Noturus gyrinus (Mitchill) Tadpole madtom
Noturus hildebrandi Least madtom
Noturus insignis Margined madtom
Noturus miurus (Jordan) Brindled madtom
Noturus nocturnus (Jordan & Gilbert) Freckled madtom
Noturus phaeus (Taylor Brown madtom
Noturus stigmosus (Taylor)Northern madtom
Noturus trautmani Scioto madtom

Order: ANGUILLIFORMES
Family: ANGUILLIDAE
Genus: ANGUILLA
Anguilla rostrata (LeSueur) American eel

Order: GADIFORMES
Family: GADIDAE
Genus: LOTA
Lota lota lacustris

Order: GASTEROSTEIFORMES
Family: GASTEROSTEIDAE
Genus: EUCALIA
Eucalia inconstans Brook stickleback

Order: CYPRINODONTIFORMES
Family: CYPRINODONTIDAE
Genus: FUNDULUS
Fundulus catenatus (Storer) Northern studfish

Fundulus diaphanus (LeSueur) Banded killifish
Fundulus notatus (Rafinesque) Blackstripe topminnow
Fundulus notti (Agassizi) Starhead topminnow
Fundulus olivaceus (Storer) Blackspotted topminnow

Family: POECILIDAE
Genus: GAMBUSIA
Gambusia affinis (Baird & Girard) Mosqsuitofish

Order: PERCOPSIFORMES
Family: PERCOPSIDAE
Genus: PERCOPSIS
Percopsis omiscomaycus (Walbaum) Troutperch

Family: APHREDODERIDAE
Genus: APHREDODERUS
Aphredoderus sayanus (Gilliams) Pirate perch

Family: AMBLYOPSIDAE
Genus: CHOLOGASTER
Chologaster agassizi (Putnam) Karst springfish
Genus:
Genus: TYPHLICHTHYS
Typhlichthys subterraneus (Girard) Lesser blindfish

Genus: AMBLYOPSIS
Amblyopsis spelaea (DeKay)Mammoth cave blindfish

Order: MUGULIFORMES
Family: ATHERINIDAE
Genus: MENIDIA
Menidia audens (Hay) Mississippi silverside

Genus: LABIDESTHES
Labidesthes sicculus (Cope) Brook silverside

Order: PERDIFORMES
Family: SERRANIDAE
Genus: MORONE
Morone chrysops (Rafinesque) White bass
Morone mississippiensis (Jordan & Eigemann) Yellow bass
Morone saxatilis (Walbaum) Striped bass

Family: CENTRARCHIDAE
Genus: MICROPTERUS
Micropterus coosae (Hubbs & Bailey) Redeye bass
Micropterus dolomieui (Lacepede) Smallmouth bass
Micropterus punctulatus (Rafinesque) Spotted bass
Micropterus salmoides (Lacepede) Largemouth bass

Genus: LEPOMIS
Lepomis auritus
Lepomis cyanellus (Rafinesque) Green sunfish
Lepomis gibbosus (Linnaeus) Pumpkinseed
Lepomis gulosus

Lepomis humilis (Girard) Orangespotted sunfish
Lepomis macrochirus (Rafinesque) Bluegill
Lepomis marginatus Dollar sunfish
Lepomis megalotis (Rafinesque) Longear sunfish
Lepomis microlophus (Gunther) Redear sunfish
Lepomis punctatus (Valenciennes) Spotted sunfish
Lepomis symmetricus (Forbes) Bantam sunfish

Genus: AMBLOPLITES
Ambloplites rupestris (Rafinesque) Rock bass

Genus: POMOXIS
Pomoxis annularis (Rafinesque) White crappie
Pomoxis nigromaculatus (LeSueur) Black crappie

Genus: CENTRARCHUS
Centrarchus macropterus (Lacepede) Flier

Genus: ELASSOMA
Elassoma zonatum (Jordan) Banded pigmy sunfish

Family: PERCIDAE
Genus: PERCA
Perca flavescens (Mitchill) Yellow perch

Genus: STIZOSTEDION
Stizostedion canadense (Smith) Sauger
Stizostedion vitreum (Mitchill) Walleye

Genus: PERCINA
Percina caprodes (Rafinesque) Logperch
Percina copelandi (Jordan) Channel darter
Percina crassa
Percina cymatotaenia (Gilbert & Meek) Bluestripe darter
Percina evides (Jordan & Copeland) Gilt darter
Percina macrocephala (Nelson) Slenderhead darter
Percina maculata (Girard) Blackside darter
Percina phoxocephala (Nelson) Slenderhead darter
Percina sciera (Swain) Dusky darter
Percian shumardi (Girard) river darter
Percina squamata (Gilbert & Swain) Olive darter
Percina uranidea (Jordan & Gilbert) Stargazing darter
Percina oxyrhyncha

Genus: AMMOCRYPTA
Ammocrypta clara (Jordan & Meek) Western sand darter
Ammocrypta pellucida (Putnam) Eastern sand darter

Genus: ETHEOSTOMA
Etheostoma aspringene (Forbes) Mud darter
Etheostoma atripinne (Jordan) Snubnose darter
Etheostoma bellum (Zorach) Orangefin darter
Etheostoma blennioides (Rafinesque) Greenside darter

Etheostoma caeruleum (Storer) Rainbow darter
Etheostoma camurum (Cope) Bluebreast darter
Etheostoma chlorosomum (Hay) Bluntnose darter
Etheostoma cinereum (Storer) Ashy darter
Etheostoma exile Iowa darter
Etheostoma flabellare (Rafinesque) Fantail darter
Etheostoma gracile (Girard) Slough darter
Etheostoma histrio (Jordan & Gilbert) Harlequin darter
Etheostoma kanawhae Kanawha darter
Etheostoma kennicotti (Putnam) Stripetail darter
Etheostoma maculatum (Kirtland) Spotted darter
Etheostoma microlepidum (Raney & Zorach) Smallscale darter
Etheostoma microperca (Jordan & Gilbert) Least darter
Etheostoma neopterum Lollipop darter
Etheostoma nigrum (Rafinesque) Johnny darter
Etheostoma obeyense (Kirsh) Barcheek darter
Etheostoma osburni Finescaled saddled darter
Etheostoma parvipinne Goldstripe darter
Etheostoma proeliare (Hay) Cypress darter
Etheostoma rufilineatum (Cope) Redline darter
Etheostoma sagitta (Jordan & Swain) Arrow darter
Etheostoma spectabile (Agassizi) Orangethroat darter
Etheostoma squamiceps (Jordan) Spottail darter
Etheostoma stigmaeum (Jordan) Speckled darter
Etheostoma swaini Gulf darter
Etheostoma tippecanoe (Jordan & Evermann) Tippecanoe darter
Etheostoma variatum (Kirtland) Variegate darter
Etheostoma virgatum (Jordan) Striped darter
Etheostoma zonale (Cope) Banded darter

Family: SCIAENIDAE
Genus: APLODINOTUS
Aplodinotus grunniens (Rafinesque) Freshwater drum

Family: COTTIDAE
Genus: COTTUS
Cottus bairdi (Girard) Mottled sculpin
Cottus carolinae (Gill) Banded sculpin

APPENDIX B: ALPHABETICAL LISTING OF FISHES OF THE ORBES REGION

SCIENTIFIC NAME - COMMON NAME

Acipenser fulvescens	Lake sturgeon
Alosa alabamae	Alabama shad
Alosa chrysochloris	Skipjack herring
Alosa pseudoharengus	Alewife
Ambloplites rupestris	Rock bass
Amblopsis spelaea	Mammoth cave blindfish
Amia calva	Bowfin
Ammocrypta clara	Western sand darter
Ammocrypta pellucida	Eastern sand darter
Anguilla rostrata	American eel
Aphredoderus sayanus	Pirate perch
Aplodinotus grunniens	Freshwater drum
Campostoma anomalum	Stoneroller
Campostoma oligolepis	Largescale stoneroller
Carrassius auratis	Goldfish
Carpiodes carpio	Rivercarpsucker
Carpiodes cyprinus	Quillback
Carpiodes velifer	Highfin carpsucker
Catastomus catostomus	Longnose sucker
Catostomus commersoni	White sucker
Centrarchus macropterus	Flier
Chologaster agassizi	Karst springfish
Chrosomus erythrogaster	Southern redbelly dace
Chrosomus oreas	Mountain redbelly dace
Clinostomus elongatus	Redside dace
Clinostomus funduloides	Rosyside dace
Clinostomus vandoisulus	Rosy dace
Cottus bairdi	Mottled sculpin
Cottus carolinae	Banded sculpin
Ctenopharyngodon idella	Grass carp
Cycleptus elongatus	Blue sucker
Cyprinus carpio	Carp
Dionda nubila	Ozark minnow
Dorosoma cepedianum	Gizzard shad
Dorosoma petense	Threadfin shad
Elassoma zonatum	Banded pygmy sunfish
Ericymba buccata	Silverjaw minnow
Erimyzon oblongus	Creek chubsucker
Erimyzon sucetta	Lake chubsucker
Esox americanus americanus	Redfin pickerel
Esox americanus vermiculatus	Grass pickerel
Esox lucius	Northern pike
Esox masquinongy	Muskellunge
Esox niger	Chain pickerel
Etheostoma aspringene	Mud darter
Etheostoma atripinne	Snubnose darter
Etheostoma bellum	Orangefin darter
Etheostoma blennioides	Greenside darter
Etheostoma caeruleum	Rainbow darter

Alphabetical Listing (Cont'd.)

Etheostoma camurum	Bluebreast darter
Etheostoma chlorosomum	Bluntnose darter
Etheostoma cinereum	Ashy darter
Etheostoma exile	Iowa darter
Etheostoma flabellare	Fantail darter
Etheostoma gracile	Slough darter
Etheostoma histrio	Harlequin darter
Etheostoma kanawhae	Kanawha darter
Etheostoma kennicotti	Stripetail darter
Etheostoma maculatum	Spotted darter
Etheostoma microlepidum	Smallscale darter
Etheostoma microperca	Least darter
Etheostoma neopterum	Lollipop darter
Etheostoma nigrum	Johnny darter
Etheostoma obeyense	Barcheek darter
Etheostoma osburni	Finescaled saddled darter
Etheostoma parvipinne	Goldstripe darter
Etheostoma proeliare	Cypress darter
Etheostoma rufilineatum	Redline darter
Etheostoma sagitta	Arrow darter
Etheostoma spectabile	Orangethroat darter
Etheostoma squamiceps	Spottail darter
Etheostoma stigmaeum	Speckled darter
Etheostoma swaini	Gulf darter
Etheostoma tippecanoe	Tippecanoe darter
Etheostoma variatum	Variegate darter
Etheostoma virgatum	Striped darter
Etheostoma zonale	Banded darter
Eucalia inconstans	Brook stidkleback
Fundulus catenatus	Northern studfish
Fundulus diaphanus	Banded killifish
Fundulus notatus	Blackstripe topminnow
Fundulus notti	Starhead topminnow
Fundulus olivaceus	Blackspotted topminnow
Gambusia affinis	Mosquitofish
Hiodon alosoides	Goldeye
Hiodon tergius	Mooneye
Hybognathus argyritis	Western silver minnow
Hybognathus hankinsoni	Brassy minnow
Hybognathus hayi	Cypress minnow
Hybognathus nuchalis	Silvery minnow
Hybognathus placitus	Plains minnow
Hybopsis aestivalis	Speckled chub
Hybopsis amblops	Bigeye chub
Hybopsis biguttata	Horneyhead chub
Hybopsis dissimilis	Streamline chub
Hybopsis gelida	Sturgeon chub
Hybopsis gracilis	Flathead chub
Hybopsis insignis	Blotched chub
Hybopsis meeki	Sicklefin chub
Hybopsis micropogon	River chub

Alphabetical Listing (Cont'd.)

Hybopsis storeriana	Silver chub
Hybopsis x-punctata	Gravel chub
Hypentelium nigricans	Northern hog sucker
Ichthyomyzon bdellium	Ohio lamprey
Ichthyomyzon castaneus	Chestnut lamprey
Ichthyomyzon fossor	Northern brook lamprey
Ichthyomyzon greeleyi	Allegheny brook lamprey
Ichthyomyzon unicuspis	Silver lamprey
Ictalurus catus	White catfish
Ictalurus furcatus	Blue catfish
Ictalurus melas	Black bullhead
Ictalurus natalis	Yellow bullhead
Ictalurus nebulosus	Brown bullhead
Ictalurus punctatus	Channel catfish
Ictiobus bubalus	Smallmouth buffalo
Ictiobus cyprinellus	Bigmouth buffalo
Ictiobus niger	Black buffalo
Labidesthes sicculus	Brook silverside
Lampetra aegyptera	Least brook lamprey
Lampetra lamottei	American brook lamprey
Lepisosteus oculatus	Spotted gar
Lepisosteus osseus	Longnose gar
Lepisosteus platostomus	Shortnose gar
Lepisosteus spatula	Alligator gar
Lepomis auritus	
Lepomis cyanellus	Green sunfish
Lepomis cyanellus x gibossus	Hybrid sunfish
Lepomis cyanellus x humilis	Hybrid sunfish
Lepomis cyanellus x macrochirus	Hybrid sunfish
Lepomis cyanellus x megalotis	Hybrid sunfish
Lepomis gibbosus	Pumpkinseed
Lepomis gulosus	Warmouth
Lepomis humilis	Orangespotted sunfish
Lepomis macrochirus	Bluegill
Lepomis marginatus	Dollar sunfish
Lepomis megalotis	Longear sunfish
Lepomis microlophus	Redear sunfish
Lepomis punctatus	Spotted sunfish
Lepomis symmetricus	Bantam sunfish
Lota lota lacustris	American burbot
Menidia audens	Mississippi silverside
Micropterus coosae	Redeye bass
Micropterus dolomieui	Smallmouth bass
Micropterus punctulatus	Spotted bass
Micropterus salmoides	Largemouth bass
Minytrema melanops	Spotted sucker
Morone chrysops	White bass
Morone mississippiensis	Yellow bass
Morone saxatilis	Striped bass
Moxostoma anisurum	Silver redhorse

Alphabetical Listing (Cont'd.)

Moxostoma atripinne	Blackfin sucker
Moxostoma aureolum	Northern redhorse
Moxostoma breviceps	Ohio redhorse
Moxostoma carinatum	River redhorse
Moxostoma duquesni	Black redhorse
Moxostoma erythrurum	Golden redhorse
Moxostoma macrolepidotum breviceps	Southern shorthead redhorse
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse
Moxostoma rhothroecum	Torrent sucker
Moxostoma rubreques	Greater redhorse
Nocomis biguttatus	Horneyhead chub
Nocomis effusus	Redtail chub
Nocomis leptocephalus	Bluehead chub
Nocomis micropogon	River chub
Nocomis platyrhynchus	Bigmouth chub
Notemigonus crysoleucas	Golden shiner
Notropis albeolus	
Notropis amnis	Pallid shiner
Notropis ardens	Ohio rosefin shiner
Notropis ariommus	Popeye shiner
Notropis atherinoides	Emerald shiner
Notropis blennius	River shiner
Notropis boops	Bigeye shiner
Notropis buchanani	Ghost shiner
Notropis camurus	Bluntface shiner
Notropis cerasinus	
Notropis chalybaeus	Ironcolor shiner
Notropis coccogenis	Warpaint shiner
Notropis cornutus chrysocephalus	Central common shiner
Notropis deliciosus stramineus	Northeastern sand shiner
Notropis dorsalis	Bigmouth shiner
Notropis emiliae	Pugnose minnow
Notropis fumeus	Ribbon shiner
Notropis galacturus	Whitetail shiner
Notropis heterolepis	Blacknose shiner
Notropis hudsonius	Spottail shiner
Notropis leuciodus	Tennessee shiner
Notropis lutrensis	Redshiner
Notropis maculatus	Taillight shiner
Notropis photogenis	Silver shiner
Notropis procne	Swallowtail shiner
Notropis rubellus	Rosyface shiner
Notropis rubricroceus	
Notropis scabriceps	New River shiner
Notropis shumardi	Silverband shiner
Notropis spilopterus	Spotfin shiner
Notropis stramineus	Sand shiner

Alphabetical Listing (Cont'd.)

Notropis telescopus	Telescope shiner
Notropis texanus	Weed shiner
Notropis umbratilis	Redfin shiner
Notropis venustus	Blacktail shiner
Notropis volucellus	Mimic shiner
Notropis whipplei	Steelcolor shiner
Noturus elegans	Elegant madtom
Noturus eleutherus	Mountain madtom
Noturus exilis	Slender madtom
Noturus flavus	Stonecat
Noturus furiosus	Northern madtom
Noturus gyrinus	Tadpole madtom
Noturus hildebrandi	Least madtom
Noturus insignis	Margined madtom
Noturus miurus	Brindled madtom
Noturus nocturnus	Freckled madtom
Noturus phaeus	Brown madtom
Noturus stigmosus	Northern madtom
Noturus trautmani	Scioto madtom
Osmerus mordax	Rainbow smelt
Parexoglossum laurae hubbsi	Western tonguetied chub
Perca flavescens	Yellow perch
Percina caprodes	Logperch
Percina copelandi	Channel darter
Percina crassa	
Percina cyanotaenia	Bluestripe darter
Percina evides	Gilt darter
Percina macrocephala	Longhead darter
Percina maculata	Blackside darter
Percina oxyrhyncha	
Percina phoxocephala	Slenderhead darter
Percina sciera	Dusky darter
Percina shumardi	River darter
Percina squamata	Olive darter
Percina uranidea	Stargazing darter
Percopsis omiscomaycus	Troutperch
Phenacobius mirabilis	Suckermouth minnow
Phenacobius teretulus	Kanawha minnow
Phenacobius uranops	Stargazing minnow
Pimephales notatus	Bluntnose minnow
Pimephales promelas	Fathead minnow
Pimephales vigilax	Bullhead minnow
Polyodon spathula	Paddlefish
Pomoxis annularis	White crappie
Pomoxis nigromaculatus	Black crappie
Pungitius pungitius	Ninespine stickleback
Pylodictis olivarus	Flathead catfish
Rhinichthys atratulus	Blacknose dace
Rhinichthys cataractae	Longnose dace
Salmo gairdneri	Rainbow trout
Salmo trutta	Brown trout
Salvelinus fontinalis	Brook trout

Alphabetical Listing (Cont'd.)

Scaphirhynus alba	Pallid sturgeon
Scaphirhynus platorynchus	Shovelnose sturgeon
Semotilus atromaculatus	Creek chub
Semotilus margarita	Pearl dace
Stizostedion canadense	Sauger
Stizostedion vitreum	Walleye
Typhlinchthys subterraneus	Lesser blindfish
Umbra limi	Central mudminnow

APPENDIX C

The distribution of the 258 fish species in the 70 major waterways of the ORBES region is presented in matrix form on the following pages. The fish species are listed along the left margin. Columns are numbered with each number representing an ORBES waterway. The rivers and streams represented by the numbers are listed on pages C1 and C2 of this appendix. A check mark after any species signifies occurrence of the species in the corresponding waterway. The references for each species are listed to the right of column 70. A list of all references is given at the end of the matrix section. Following the list of references are are separate listings of the fish species for each of the 70 ORBES waterways.

Appendix C: Distribution of Fish Species in the ORBES Region

River Basin Codes

1	Mississippi - Bayou de Chien and Obion Creek
2	Tennessee River
3	Cumberland River
4	Tradewater River
5	Green River - Rough and Barren Rivers
6	Salt River
7	Licking River
8	Little Sandy River
9	Kentucky River
10	Big Sandy River
11	Lower Ohio - Cairo, Illinois to the Salt River
12	Mid-Ohio - Salt River to the Port of Cincinnati
13	Upper-mid Ohio - Port of Cincinnati to Kentucky-West Virginia border
14	Upper Ohio - Kentucky-West Virginia border to Pittsburgh
15	Great Miami River
16	Little Miami River
17	Scioto River
18	Hocking River
19	Muskingum
20	Big Yellow Creek
21	Little Beaver Creek
22	Mahoning
23	Mississippi River
24	Green River
25	Rock River
26	Kankakee River
27	Iroquois River
28	Fox River
29	Vermillion River I
30	Mackinaw River
31	Spoon River
32	Sangamon River
33	Salt Creek
34	La Moine River
35	Vermillion River II
36	Illinois River
37	Kaskaskia River
38	Big Muddy River
39	Embarras River
40	Little Wabash River
41	Wabash River
42	Saline River
43	Cache River
44	Tippecanoe River
45	Eel River
46	Salamonie River

Appendix C (cont'd.)

47 Mississinewa River
48 Deer Creek
49 Wildcat Creek
50 Sugar Creek
51 Raccoon Creek
52 Fall Creek
53 Eel River (tributary of the West Fork of the White River)
54 West Fork of the White River
55 Sugar Creek (Tributary of the East Fork of the White River)
56 Big Blue River (Tributary of the East Fork of the White River)
57 Flat Rock River
58 Muscatatuck River
59 Patoka River
60 East Fork of the White River
61 Little Pigeon Creek
62 Big Blue River
63 Laughery Creek
64 Whitewater River
65 Guyandotte River
66 Kanawha River
67 Monongahela River
68 New River
69 Allegheny River
70 Beaver River

APPENDIX C: (Cont'd.)

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	RIVER BASIN																			
Acipenser fulvescens	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓			
Alosa alabamae																				
Alosa chrysochloris		✓	✓		✓	✓		✓			✓	✓	✓	✓			✓			
Alosa pseudoharengus													✓							
Ambloplites rupestris	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amblyopsis spelaea						✓														
Amia calva	✓					✓					✓	✓					✓			
Ammocrypta clara																				
Ammocrypta pellucida							✓		✓	✓					✓	✓	✓	✓	✓	
Anguilla rostrata	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	
Aphredoderus sayanus	✓	✓	✓	✓	✓						✓	✓								
Aplodinotus grunniens	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Campostoma anomalum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Campostoma oligolepis																				
Carassius auratus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	

APPENDIX C: (Cont'd.)

SPECIES	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	RIVER BASIN																			
Acipenser fulvescens			✓																	
Alosa alabamae			✓																	
Alosa chrysochloris			✓						✓							✓	✓	✓	✓	
Alosa pseudoharengus																				
Ambloplites rupestris	✓	✓			✓	✓	✓	✓	✓	✓		✓			✓	✓	✓		✓	
Amblyopsis spelaea																				
Amia calva			✓			✓										✓	✓	✓		✓
Ammocrypta clara			✓														✓			
Ammocrypta pellucida									✓										✓	✓
Anguilla rostrata	✓		✓		✓				✓							✓	✓		✓	
Aphredoderus sayanus			✓			✓										✓	✓	✓	✓	✓
Aplodinotus grunniens			✓		✓							✓	✓	✓		✓	✓		✓	✓
Campostoma anomalum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Campostoma oligolepis								✓					✓			✓				
Carassius auratus					✓											✓				

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RIVER BASIN																			
Acipenser fulvescens	✓				✓															✓
Alosa alabamae																				
Alosa chrysochloris	✓																			
Alosa pseudoharengus																				
Ambloplites rupestris	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Amblyopsis spelaea																				
Amia calva	✓		✓											✓				✓		
Ammocrypta clara																				
Ammocrypta pellucida	✓			✓	✓	✓				✓	✓	✓	✓	✓			✓	✓		
Anguilla rostrata	✓			✓										✓						
Aphredoderus sayanus	✓		✓		✓							✓						✓	✓	
Aplodinotus grunniens	✓		✓											✓				✓	✓	✓
Campostoma anomalum	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Campostoma oligolepis																				
Carassius auratus											✓	✓		✓						

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Acipenser fulvescens					✓						3,4,17,17,20
Alosa alabamae		✓									20
Alosa chrysochloris					✓	✓					1,2,3,4,7,8,17,19,20,22,25
Alosa pseudoharengus					✓	✓		✓			2,3,18,20
Ambloplites rupestris		✓	✓	✓	✓	✓	✓	✓	✓	✓	1,2,3,4,8,9,10,11,12,13,14,15,16,17, 18,20,21,22
Amblyopsis spelaea											1
Amia calva					✓	✓					1,2,3,4,7,11,14,17,18,19,20,25
Ammocrypta clara											20
Ammocrypta pellucida					✓	✓					1,2,4,17,20
Anguilla rostrata		✓			✓	✓					1,2,3,4,6,13,17,18,19,20
Aphredoderus sayanus	✓										1,4,11,14,18,20
Aplodinotus grunniens	✓	✓			✓						1,3,4,6,8,14,17,18,19,20,22,25
Campostoma anomalum		✓	✓	✓	✓	✓		✓	✓	✓	1,2,3,4,5,6,9,10,11,12,14,15,16,17 18,20,21,22,25
Campostoma oligolepis											20
Carassius auratus		✓			✓	✓	✓		✓		1,2,3,4,6,8, ,15,17,18,20,21

APPENDIX C: (Cont'd.)

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	RIVER BASIN																			
Carpiodes carpio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Carpiodes cyprinus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Carpiodes velifer	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Catastomus catostomus																				
Catostomus commersoni			✓			✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
Centrarchus macropterus	✓	✓	✓	✓	✓															
Chologaster agassizi			✓			✓														
Chrosomus erythrogaster						✓				✓					✓	✓	✓	✓	✓	
Chrosomus oreas																				
Clinostomus elongatus							✓							✓	✓		✓			✓
Clinostomus funduloides		✓	✓					✓		✓										
Clinostomus vandiosulus																	✓			
Cottus bairdi							✓	✓	✓	✓					✓		✓			
Cottus carolinae			✓		✓	✓			✓		✓									
Ctenopharyngodon idella																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Carpiodes carpio	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓
Carpiodes cyprinus	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Carpiodes velifer																				
Catastomus catostomus																				
Catostomus commersoni	✓	✓	✓																	
Centrarchus macropterus																				
Chologaster agassizi																				
Chrosomus erythrogaster	✓	✓	✓																	
Chrosomus oreas																				
Clinostomus elongatus	✓	✓																		
Clinostomus funduloides																				
Clinostomus vandiosulus																				
Cottus bairdi																				
Cottus carolinae			✓																	
Ctenopharyngodon idella			✓																	

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Carpiodes carpio	✓		✓	✓					✓	✓					✓			✓	✓	
Carpiodes cyprinus	✓	✓	✓	✓	✓						✓	✓	✓	✓	✓			✓	✓	
Carpiodes velifer	✓									✓	✓		✓	✓	✓			✓		✓
Catastomus catostomus																				
Catostomus commersoni	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Centrarchus macropterus		✓	✓															✓	✓	
Chologaster agassizi																				
Chrosomus erythrogaster								✓			✓			✓		✓				
Chrosomus oreas																				
Clinostomus elongatus																				
Clinostomus funduloides																				
Clinostomus vandiosulus																				
Cottus bairdi	✓			✓	✓	✓			✓	✓	✓	✓			✓	✓				
Cottus carolinae			✓																✓	
Ctenopharyngodon idella																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN										References
	61	62	63	64	65	66	67	68	69	70	
Carpiodes carpio		✓			✓	✓	✓				1,2,3,4,5,6,11,13,14,16,17,18, 19,20,25
Carpiodes cyprinus		✓		✓	✓	✓			✓		1,2,3,4,5,6,8,9,10,11,12,13,14,15, 17,18,19,20,21,25
Carpiodes velifer				✓	✓						1,2,3,4,5,8,14,15,17,20
Catastomus catostomus					✓		✓				2,3
Catostomus commersoni		✓		✓	✓	✓	✓	✓	✓	✓	1,2,3,4,5,6,8,9,10,11,12,13,14,15,16 17,18,20,21,22,25
Centrarchus macropterus	✓										1,4,14,20
Chologaster agassizi											1,20
Chrosomus erythrogaster		✓		✓	✓	✓				✓	2,3,4,6,12,15,17,20,22
Chrosomus oreas						✓		✓			2,3
Clinostomus elongatus					✓		✓			✓	1,2,3,17
Clinostomus funduloides					✓	✓		✓			1,2,3,24
Clinostomus vandiosulus											17
Cottus bairdi		✓		✓	✓	✓		✓	✓		1,2,3,4,5,9,11,12,15,16,17,20,21
Cottus carolinae		✓		✓		✓		✓			1,2,4,6,20,22
Ctenopharyngodon idella											20

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cycleptus elongatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Cyprinus carpio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dionda nubila																				
Dorosoma cepedianum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Dorosoma petense											✓	✓	✓	✓						
Elassoma zonatum	✓																			
Ericymba buccata						✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓
Erimyzon oblongus	✓	✓	✓		✓	✓	✓								✓		✓			
Erimyzon sucetta	✓	✓	✓	✓	✓						✓						✓			
Esox americanus americanus																				
Esox americanus vermiculatus	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓		✓	
Esox lucius																				
Esox masquinongy					✓	✓	✓	✓	✓					✓						
Esox niger	✓										✓								✓	
Etheostoma asprigene	✓	✓	✓		✓															

APPENDIX C: (Cont'd.)

SPECIES	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	RIVER BASIN																			
Cycleptus elongatus			✓													✓	✓			
Cyprinus carpio	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dionda nubila			✓		✓															
Dorosoma cepedianum	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dorosoma petense			✓														✓			
Elassoma zonatum																		✓		
Ericymba buccata	✓	✓	✓			✓	✓		✓							✓	✓		✓	✓
Erimyzon oblongus																	✓		✓	✓
Erimyzon sucetta						✓							✓			✓				
Esox americanus americanus						✓														
Esox americanus vermiculatus			✓	✓	✓	✓			✓			✓				✓	✓	✓	✓	✓
Esox lucius			✓		✓	✓										✓			✓	
Esox masquinongy																				
Esox niger																				
Etheostoma asprigene			✓									✓	✓			✓	✓	✓	✓	✓

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RIVER BASIN																			
Cycleptus elongatus	✓																	✓		
Cyprinus carpio	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓		✓	✓	✓
Dionda nubila																				
Dorosoma cepedianum	✓	✓	✓	✓	✓		✓		✓	✓	✓			✓	✓			✓		✓
Dorosoma petense	✓	✓																		
Elassoma zonatum			✓																	
Ericymba buccata	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Erimyzon oblongus	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Erimyzon sucetta																				
Esox americanus americanus																				
Esox americanus vermiculatus	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	
Esox lucius	✓			✓																
Esox masquinongy																				✓
Esox niger																				
Etheostoma asprigene	✓		✓																	

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Cycleptus elongatus					✓						1,3,17,20
Cyprinus carpio		✓		✓	✓	✓	✓	✓	✓		1,3,4,5,6,7,8,9,10,11,12,13,14,15,16 17,18,19,20,21,22,25
Dionda nubila											10
Dorosoma cepedianum		✓		✓	✓	✓	✓		✓		1,2,3,4,5,6,7,8,9,10,11,13,14,15,16 17,18,19,20,21,22,25
Dorosoma petense					✓	✓					1,2,3,20,25
Elassoma zonatum											1
Ericymba buccata		✓	✓	✓	✓	✓				✓	1,2,3,4,5,6,7,9,11,12,14,15,17,20,22
Erimyzon oblongus		✓									1,3,4,9,14,15,17,20
Erimyzon sucetta											1,5,6,10,11
Esox americanus americanus					✓						3
Esox americanus vermiculatus	✓	✓		✓	✓					✓	1,3,4,5,6,7,9,10,11,12,13,14,15,17,20
Esox lucius					✓				✓		1,3,4,8,11,13,19,20,21
Esox masquinongy					✓	✓					1,2,3,4,
Esox niger					✓	✓					1,2,3,17,24
Etheostoma asprigene		✓									1,4,6,20

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Etheostoma atripinne			✓		✓															
Etheostoma bellum					✓															
Etheostoma blennioides				✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
Etheostoma caeruleum			✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓
Etheostoma camurum			✓		✓				✓								✓		✓	
Etheostoma chlorosomum	✓				✓						✓									
Etheostoma cinereum		✓	✓																	
Etheostoma exile																✓			✓	
Etheostoma flabellare		✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓
Etheostoma gracile	✓			✓	✓						✓									
Etheostoma histrio		✓																		
Etheostoma kanawhae																				
Etheostoma kennicotti			✓		✓		✓				✓									
Etheostoma maculatum			✓		✓		✓		✓								✓			
Etheostoma microlepidum			✓																	

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN																			
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Etheostoma atripinne																				
Etheostoma bellum																				
Etheostoma blennioides	✓	✓				✓			✓										✓	✓
Etheostoma caeruleum	✓	✓			✓	✓		✓	✓							✓			✓	
Etheostoma camurum									✓											
Etheostoma chlorosomum			✓													✓	✓	✓	✓	✓
Etheostoma cinereum																				
Etheostoma exile									✓											
Etheostoma flabellare	✓	✓			✓				✓	✓						✓			✓	
Etheostoma gracile																✓	✓	✓	✓	✓
Etheostoma histrio																			✓	
Etheostoma kanawhae																				
Etheostoma kennicotti																				
Etheostoma maculatum																				
Etheostoma microlepidum																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN																			
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Etheostoma atripinne																				
Etheostoma bellum																				
Etheostoma blennioides	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Etheostoma caeruleum	✓																			
Etheostoma camurum																				
Etheostoma chlorosomum	✓	✓																		
Etheostoma cinereum																				
Etheostoma exile																				
Etheostoma flabellare																				
Etheostoma gracile	✓	✓																		
Etheostoma histrio																				
Etheostoma kanawhae																				
Etheostoma kennicotti		✓																		
Etheostoma maculatum																				
Etheostoma microlepidum																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Etheostoma atripinne											1
Etheostoma bellum											1
Etheostoma blennioides		✓	✓	✓	✓	✓		✓		✓	1,2,3,4,5,6,9,11,12,14,15,16,17,20,22
Etheostoma caeruleum		✓	✓	✓	✓	✓		✓		✓	1,2,3,4,5,14,15,16,17,20,22
Etheostoma camurum		✓			✓	✓					1,2,3,4,5,17,20
Etheostoma chlorosomum											1,4,20
Etheostoma cinereum											1
Etheostoma exile											5,15,20
Etheostoma flabellare		✓	✓	✓	✓			✓	✓	✓	1,2,3,4,5,6,12,14,15,17,20,21,22
Etheostoma gracile											1,4,20
Etheostoma histrio											1,20
Etheostoma kanawhae						✓		✓			2,3
Etheostoma kennicotti											1,20,23
Etheostoma maculatum						✓					1,2,17
Etheostoma microlepidum											1

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Etheostoma microperca					✓	✓						✓			✓		✓			
Etheostoma neopterum		✓																		
Etheostoma nigrum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓
Etheostoma obeyense			✓																	
Etheostoma osburni																				
Etheostoma parvipinne	✓	✓																		
Etheostoma proeliare	✓	✓	✓								✓									
Etheostoma rufilineatum		✓	✓																	
Etheostoma sagitta			✓						✓											
Etheostoma spectabile			✓		✓	✓	✓	✓	✓	✓					✓	✓	✓			
Etheostoma squamiceps		✓			✓															
Etheostoma stigmaeum		✓	✓		✓															
Etheostoma swaini	✓																			
Etheostoma tippecanoe		✓	✓				✓		✓								✓		✓	
Etheostoma variatum							✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN																			
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Etheostoma microperca						✓														
Etheostoma neopterum																				
Etheostoma nigrum				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Etheostoma obeyense																				
Etheostoma osburni																				
Etheostoma parvipinne																				
Etheostoma proeliare																				
Etheostoma rufilineatum																				
Etheostoma sagitta																				
Etheostoma spectabile			✓			✓	✓	✓	✓	✓		✓		✓					✓	✓
Etheostoma squamiceps																				
Etheostoma stigmaeum																				
Etheostoma swaini																				
Etheostoma tippecanoe																				
Etheostoma variatum	✓	✓																		

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RIVER BASIN																			
Etheostoma microperca				✓				✓	✓	✓	✓		✓				✓			
Etheostoma neopterum																				
Etheostoma nigrum	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Etheostoma obeyense																				
Etheostoma osburni																				
Etheostoma parvipinne																				
Etheostoma proeliare			✓																	
Etheostoma rufilineatum																				
Etheostoma sagitta																				
Etheostoma spectabile		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		
Etheostoma squamiceps																				
Etheostoma stigmaeum																				
Etheostoma swaini																				
Etheostoma tippecanoe				✓																✓
Etheostoma variatum																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN										References
	61	62	63	64	65	66	67	68	69	70	
Etheostoma microperca											1,4,17,20
Etheostoma neopterum											23,24
Etheostoma nigrum	✓	✓	✓	✓	✓	✓			✓	✓	1,2,3,4,5,6,9,11,12,14,15,16,17,20,21,22
Etheostoma obeyense											1
Etheostoma osburni						✓		✓			2,3,
Etheostoma parvipinne											24
Etheostoma proeliare											1,20,24
Etheostoma rufilineatum											1
Etheostoma sagitta											1
Etheostoma spectabile		✓		✓							1,4,6,9,11,12,14,17,20
Etheostoma squamiceps											1
Etheostoma stigmaeum											1
Etheostoma swaini											23,24
Etheostoma tippecanoe					✓	✓					1,2,3,4,17
Etheostoma variatum		✓		✓	✓	✓					1,2,3,4,17

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Etheostoma virgatum			✓		✓															
Etheostoma zonale	✓		✓		✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓
Eucalia inconstans															✓				✓	
Fundulus catenatus		✓	✓		✓	✓			✓											
Fundulus diaphanus														✓						✓
Fundulus notatus	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓				✓	✓			
Fundulus notti																				
Fundulus olivaceus	✓	✓	✓								✓									
Gambusia affinis	✓	✓	✓		✓						✓									
Hiodon alosoides	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓			
Hiodon tergius	✓	✓	✓	✓	✓	✓					✓	✓		✓			✓			
Hybognathus argyritis																				
Hybognathus hankinsoni																				
Hybognathus hayi	✓										✓									
Hybognathus nuchalis	✓	✓			✓				✓		✓	✓								

APPENDIX C: (Cont'd.)

SPECIES	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	RIVER BASIN																			
Etheostoma virgatum																				
Etheostoma zonale	✓	✓	✓	✓		✓	✓	✓		✓		✓	✓			✓				
Eucalia inconstans	✓	✓			✓			✓												
Fundulus catenatus			✓																	
Fundulus diaphanus																				
Fundulus notatus			✓	✓	✓	✓	✓	✓	✓			✓	✓		✓		✓	✓	✓	✓
Fundulus notti						✓										✓		✓		
Fundulus olivaceus																		✓		
Gambusia affinis			✓	✓	✓				✓				✓			✓	✓	✓	✓	✓
Hiodon alosoides			✓									✓				✓	✓		✓	
Hiodon tergius			✓	✓	✓											✓				
Hybognathus argyritis			✓										✓			✓	✓			
Hybognathus hankinsoni								✓												
Hybognathus hayi																				
Hybognathus nuchalis			✓						✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RIVER BASIN																			
Etheostoma virgatum																				
Etheostoma zonale																				
Eucalia inconstans																				
Fundulus catenatus															✓		✓			
Fundulus diaphanus																				
Fundulus notatus	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Fundulus notti				✓																
Fundulus olivaceus			✓																	
Gambusia affinis	✓	✓	✓																	
Hiodon alosoides	✓																			
Hiodon tergius	✓													✓						✓
Hybognathus argyritis	✓																			
Hybognathus hankinsoni																				
Hybognathus hayi																				
Hybognathus nuchalis	✓	✓	✓			✓			✓	✓	✓		✓	✓				✓	✓	✓

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Etheostoma virgatum											1
Etheostoma zonale		✓		✓	✓	✓			✓		1,2,3,4,12,17,20,21,22,24
Eucalia inconstans										✓	17,20
Fundulus catenatus											1,4,20
Fundulus diaphanus		✓			✓		✓		✓		2,3,6,17,18,20
Fundulus notatus	✓	✓									1,4,5,6,9,11,14,15,20,22
Fundulus notti											1,4,11,20
Fundulus olivaceus											1,20
Gambusia affinis											1,4,20
Hiodon alosoides					✓						1,3,4,17,19;20
Hiodon tergius					✓						1,3,4,7,17,18,19,20
Hybognathus argyritis											20
Hybognathus hankinsoni											20
Hybognathus hayi	✓										4,20
Hybognathus nuchalis	✓										1,4,10,14,15,20,25

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Hybognathus placitus																				
Hybopsis aestivalis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	
Hybopsis amblops						✓								✓	✓		✓	✓	✓	✓
Hybopsis biguttata																	✓			
Hybopsis dissimilis			✓		✓				✓	✓							✓		✓	
Hybopsis gelida																				
Hybopsis gracilis	✓																			
Hybopsis insignis		✓	✓	✓																
Hybopsis meeki																				
Hybopsis micropogon															✓		✓	✓	✓	✓
Hybopsis storeriana	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Hybopsis x-punctata											✓	✓	✓	✓	✓	✓	✓	✓	✓	
Hypentelium nigricans					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ichthyomyzon bdellium	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Ichthyomyzon castaneus		✓	✓																	

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN																			
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Hybognathus placitus			✓																	
Hybopsis aestivalis			✓						✓							✓	✓			
Hybopsis amblops	✓								✓										✓	✓
Hybopsis biguttata						✓														
Hybopsis dissimilis																				
Hybopsis gelida			✓																	
Hybopsis gracilis			✓																	
Hybopsis insignis																				
Hybopsis meeki			✓																	
Hybopsis micropogon	✓	✓																		
Hybopsis storeriana			✓		✓							✓				✓	✓		✓	
Hybopsis x-punctata			✓		✓															
Hypentelium nigricans	✓	✓		✓	✓	✓			✓	✓			✓	✓	✓	✓	✓	✓	✓	
Ichthyomyzon bdellium																✓	✓	✓		
Ichthyomyzon castaneus			✓																	

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RIVER BASIN																			
Hybognathus placitus																				
Hybopsis aestivalis	✓																			
Hybopsis amblops	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Hybopsis biguttata	✓				✓				✓	✓	✓				✓					
Hybopsis dissimilis																	✓			
Hybopsis gelida																				
Hybopsis gracilis																				
Hybopsis insignis																				
Hybopsis meeki																				
Hybopsis micropogon					✓						✓									
Hybopsis storeriana	✓									✓	✓		✓	✓				✓		
Hybopsis x-punctata	✓																			
Hypentelium nigricans	✓			✓	✓				✓	✓	✓			✓				✓		
Ichthyomyzon bdellium	✓			✓																
Ichthyomyzon castaneus	✓																			

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Hybognathus placitus											20
Hybopsis aestivalis						✓					1,2,3,17,20
Hybopsis amblops						✓					1,2,3,4,17,20,22,7,9,14,16
Hybopsis biguttata											1,5,9,11,15,16
Hybopsis dissimilis						✓			✓		1,2,3,4,17,21
Hybopsis gelida											20
Hybopsis gracilis											1,20
Hybopsis insignis											1
Hybopsis meeki											20
Hybopsis micropogon				✓							9,12,15,17
Hybopsis storeriana		✓	✓	✓	✓	✓					1,2,3,4,14,15,17,18,20,25
Hybopsis x-punctata											1,7,17,20
Hypentelium nigricans		✓		✓	✓	✓		✓	✓		1,2,3,4, ,6,8,9,10,11,12,13,14,16 17,20,22
Ichthyomyzon bdellium					✓	✓					1,2,3,4,17,20
Ichthyomyzon castaneus											1

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ichthyomyzon fossor		✓			✓				✓	✓							✓			
Ichthyomyzon greeleyi					✓				✓											
Ichthyomyzon unicuspis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓			
Ictalurus catus											✓	✓		✓						
Ictalurus furcatus	✓										✓	✓	✓		✓	✓	✓			
Ictalurus melas	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ictalurus natalis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	
Ictalurus nebulosus					✓	✓	✓				✓	✓	✓	✓		✓	✓		✓	✓
Ictalurus punctatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ictiobus bubalus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Ictiobus cyprinellus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Ictiobus niger											✓	✓	✓	✓	✓	✓	✓			
Labidesthes sicculus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						✓	✓		
Lampetra aegyptera	✓	✓	✓		✓	✓	✓			✓				✓						
Lampetra lamottei			✓		✓			✓	✓	✓										

APPENDIX C: (Cont'd.)

SPECIES	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	RIVER BASIN																			
Ichthyomyzon fossor						✓														
Ichthyomyzon greeleyi	✓	✓																		
Ichthyomyzon unicuspis			✓			✓			✓								✓	✓	✓	✓
Ictalurus catus			✓													✓	✓			
Ictalurus furcatus			✓													✓	✓			
Ictalurus melas	✓	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Ictalurus natalis	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Ictalurus nebulosus	✓	✓				✓							✓			✓	✓	✓		
Ictalurus punctatus	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓
Ictiobus bubalus			✓			✓						✓	✓			✓	✓			✓
Ictiobus cyprinellus			✓		✓	✓						✓	✓	✓		✓		✓	✓	
Ictiobus niger			✓			✓						✓	✓			✓	✓		✓	
Labidesthes sicculus			✓		✓	✓			✓							✓	✓	✓	✓	✓
Lampetra aegyptera																				
Lampetra lamottei						✓		✓					✓						✓	

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ichthyomyzon fossor				✓																
Ichthyomyzon greeleyi																				
Ichthyomyzon unicuspis				✓																
Ictalurus catus																				
Ictalurus furcatus	✓																			
Ictalurus melas	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓				✓		
Ictalurus natalis	✓	✓	✓	✓		✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	
Ictalurus nebulosus				✓										✓				✓	✓	
Ictalurus punctatus	✓		✓	✓	✓					✓	✓		✓	✓	✓			✓	✓	✓
Ictiobus bubalus	✓		✓		✓													✓		
Ictiobus cyprinellus	✓		✓	✓	✓														✓	
Ictiobus niger	✓		✓																	
Labidesthes sicculus	✓			✓	✓		✓		✓	✓	✓	✓		✓	✓	✓		✓		✓
Lampetra aegyptera	✓	✓			✓														✓	
Lampetra lamottei	✓																			

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	Referemces
Ichthyomyzon fossor											1,4,17,20,23,24
Ichthyomyzon greeleyi					✓						1,2,3,17
Ichthyomyzon unicuspis					✓						1,3,4,17,20
Ictalurus catus					✓		✓				1,2,3,19,20
Ictalurus furcatus					✓	✓					1,2,3,4,17,20,25
Ictalurus melas		✓			✓	✓				✓	1,2,3,4,6,8,9,10,11,14,16,17,18,19,20,22,25
Ictalurus natalis		✓		✓	✓	✓	✓				1,2,3,4,5,6,8,10,11,12,13,14,15,17,18,19,20,22,25
Ictalurus nebulosus		✓			✓	✓	✓		✓	✓	1,2,3,4,6,10,11,14,17,18,20,21,22,25
Ictalurus punctatus		✓	✓		✓	✓	✓	✓	✓		1,2,3,4,5,6,8,9,11,13,14,15,17,18,19,20,21,22,25
Ictiobus bubalus		✓			✓	✓			✓		1,2,3,4,6,11,14,17,18,19,20,21,25
Ictiobus cyprinellus					✓						1,4,11,17,19,20,22,25
Ictiobus niger					✓	✓					1,2,4,11,17,18,19,20
Labidesthes sicculus				✓	✓	✓					1,2,3,4,12,14,15,17,18,20,22
Lampetra aegyptera					✓	✓					1,2,3,4,9,17,20,24
Lampetra lamottei				✓	✓						1,3,4,7,20

APPENDIX C: (Cont'd.)

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	RIVER BASIN																			
Lepisosteus oculatus	✓										✓									
Lepisosteus osseus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	
Lepisosteus platostomus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓			
Lepisosteus spatula	✓										✓	✓	✓							
Lepomis auritus																				
Lepomis cyanellus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lepomis c x humilis						✓														
Lepomis c x macrochirus																				
Lepomis c x megalotis						✓														
Lepomis c x gibossus																				
Lepomis gibossus												✓	✓	✓		✓		✓		
Lepomis gulosus	✓			✓	✓						✓	✓	✓	✓		✓	✓		✓	
Lepomis humilis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓			
Lepomis h x macrochirus						✓														
Lepomis macrochirus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

APPENDIX C: (Cont'd.)

SPECIES	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Lepisosteus oculatus			✓													✓	✓	✓		
Lepisosteus osseus			✓									✓	✓			✓	✓	✓	✓	✓
Lepisosteus platostomus			✓									✓	✓			✓	✓			✓
Lepisosteus spatula			✓																	
Lepomis auritus																				
Lepomis cyanellus	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Lepomis c x humilis																				
Lepomis c x macrochirus																				
Lepomis c x megalotis																				
Lepomis c x gibossus																				
Lepomis gibossus	✓				✓	✓		✓								✓				
Lepomis gulosus		✓	✓			✓				✓		✓				✓	✓	✓	✓	✓
Lepomis humilis			✓	✓	✓	✓				✓		✓	✓		✓	✓	✓	✓	✓	✓
Lepomis h x macrochirus																				
Lepomis macrochirus	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓		✓	✓	✓	✓	✓

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RIVER BASIN																			
Lepisosteus oculatus			✓																	
Lepisosteus osseus	✓																	✓		
Lepisosteus platostomus	✓																			✓
Lepisosteus spatula																				
Lepomis auritus																				
Lepomis cyanellus	✓	✓	✓	✓	✓				✓	✓	✓			✓	✓			✓	✓	✓
Lepomis c x humilis																				
Lepomis c x macrochirus																				
Lepomis c x megalotis																				
Lepomis c x gibossus																				
Lepomis gibossus	✓			✓	✓									✓						
Lepomis gulosus	✓	✓	✓	✓														✓	✓	
Lepomis humilis	✓		✓		✓	✓	✓	✓	✓	✓				✓				✓	✓	✓
Lepomis h x macrochirus																				
Lepomis macrochirus	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Lepisosteus oculatus											1,4,19,20
Lepisosteus osseus		✓			✓	✓	✓				1,2,3,4,6,7,8,14,17,18,20,22
Lepisosteus platostomus											1,4,7,8,17,19,20,25
Lepisosteus spatula											1,20
Lepomis auritus						✓		✓			2,3
Lepomis cyanellus	✓	✓		✓	✓	✓	✓	✓		✓	1,2,3,4,5,6,8,9,10,11,12,14,15,16,17 18,19,20,22
Lepomis c x humilis											22
Lepomis c x macrochirus							✓				2
Lepomis c x megalotis											22
Lepomis c x gibossus							✓	✓			2
Lepomis gibossus					✓	✓	✓		✓		1,2,3,4,9,10,11,17,19,20,21
Lepomis gulosus		✓			✓	✓	✓				1,2,3,4,17,18,11,14,20
Lepomis humilis	✓		✓	✓	✓		✓				1,2,3,4,9,10,14,17,18,19,20,22
Lepomis h x macrochirus											22
Lepomis macrochirus		✓		✓	✓	✓	✓	✓	✓	✓	1,2,3,4,5,6,8,9,10,11,12,13,14,15,16 17,18,19,20,21,22,25

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Lepomis marginatus	✓																			
Lepomis megalotis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lepomis microlophus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓		✓	
Lepomis punctatus	✓		✓																	
Lepomis symmetricus	✓																			
Lota lota lacustris							✓				✓	✓								
Menidia audens	✓																			
Micropterus coosae			✓																	
Micropterus dolomieui	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Micropterus punctulatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Micropterus salmoides	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Minytrema melanops	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	
Morone chrysops	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Morone mississippiensis		✓	✓								✓									
Morone saxatilis			✓		✓						✓	✓		✓						

APPENDIX C: (Cont'd.)

RIVER BASIN

SPECIES	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Lepomis marginatus																				
Lepomis megalotis		✓	✓			✓			✓			✓	✓			✓	✓	✓	✓	✓
Lepomis microlophus						✓			✓			✓				✓				
Lepomis punctatus																✓				
Lepomis symmetricus																		✓		
Lota lota lacustris			✓													✓				
Menidia audens																				
Micropterus coosae																				
Micropterus dolomieui	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓		✓	
Micropterus punctulatus									✓										✓	✓
Micropterus salmoides	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Minytrema melanops			✓			✓			✓				✓			✓	✓	✓	✓	✓
Morone chrysops		✓	✓		✓			✓								✓	✓			
Morone mississippiensis			✓						✓							✓	✓		✓	
Morone saxatilis																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Lepomis marginatus																				
Lepomis megalotis	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Lepomis microlophus	✓			✓							✓							✓		
Lepomis punctatus	✓																			
Lepomis symmetricus																				
Lota lota lacustris	✓																			
Menidia audens																				
Micropterus coosae																				
Micropterus dolomieui	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Micropterus punctulatus	✓		✓						✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Micropterus salmoides	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Minytrema melanops	✓			✓	✓	✓	✓		✓	✓			✓	✓	✓	✓	✓	✓	✓	
Morone chrysops	✓		✓	✓						✓	✓				✓					
Morone mississippiensis																				
Morone saxatilis																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Lepomis marginatus											24
Lepomis megalotis	✓	✓	✓	✓	✓	✓				✓	1,2,3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,19,20,22,25
Lepomis microlophus		✓			✓						1,3,6,8,11,13,14,15,17,18,20,22
Lepomis punctatus											1,4,20,24
Lepomis symmetricus											1,20
Lota lota lacustris											1
Menidia audens		✓									1
Micropterus coosae											1
Micropterus dolomieui		✓	✓	✓	✓	✓	✓	✓	✓		1,2,3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,25
Micropterus punctulatus	✓	✓	✓	✓	✓	✓	✓	✓			1,2,3,4,5,6,14,17,18,20,22
Micropterus salmoides		✓		✓	✓	✓	✓		✓		1,2,3,4,5,6,8,9,10,11,13,14,15,16,17,18,19,20,21,22,25
Minytrema melanops		✓			✓	✓					1,2,3,4,5,6,8,9,10,11,13,14,16,17,18,20,22,25
Morone chrysops					✓	✓		✓			1,2,3,4,5,8,13,15,17,18,19,20
Morone mississippiensi		✓									1,4,20
Morone saxatilis					✓						1,3,18

APPENDIX C: (Cont'd.)

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Moxostoma anisurum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	
Moxostoma atripinne					✓															
Moxostoma aureolum																				
Moxostoma breviceps												✓	✓	✓	✓	✓	✓	✓	✓	
Moxostoma carinatum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Moxostoma duquesni	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓
Moxostoma erythrurum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Moxostoma macrolepidotum breviceps	✓																			
Moxostoma macrolepidotum m.						✓						✓		✓						
Moxostoma rhothroecum																				
Moxostoma rubreques																				
Nocomis biguttatus									✓											
Nocomis effusus			✓		✓															
Nocomis leptocephalus																				
Nocomis micropogon			✓		✓		✓	✓	✓	✓				✓						

RIVER BASIN

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Moxostoma anisurum					✓	✓			✓		✓	✓	✓			✓			✓	
Moxostoma atripinne																				
Moxostoma aureolum																				
Moxostoma breviceps	✓																			
Moxostoma carinatum						✓		✓	✓											
Moxostoma duquesni	✓				✓	✓														
Moxostoma erythrurum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
Moxostoma macrolepidotum brevic						✓														
Moxostoma macrolepidotum m.			✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Moxostoma rhothroecum																				
Moxostoma rubreques																				
Nocomis biguttatus			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Nocomis effusus																				
Nocomis leptocephalus																				
Nocomis micropogon																				

APPENDIX C: (Cont'd.)

RIVER BASIN

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Moxostoma anisurum	✓			✓					✓	✓	✓		✓	✓	✓		✓			
Moxostoma atripinne																				
Moxostoma aureolum													✓	✓						
Moxostoma breviceps	✓			✓																
Moxostoma carinatum	✓			✓						✓					✓					
Moxostoma duquesni	✓			✓	✓	✓				✓	✓		✓				✓	✓		
Moxostoma erythrurum	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
Moxostoma macro-lepidotum brevi	✓																			
Moxostoma macro-lepidotum m.	✓			✓																
Moxostoma rhothroecum																				
Moxostoma rubreques					✓															
Nocomis biguttatus	✓			✓	✓			✓	✓	✓	✓	✓			✓	✓	✓			
Nocomis effusus																				
Nocomis leptocephalus																				
Nocomis micropogon	✓			✓	✓				✓	✓		✓		✓	✓	✓	✓			

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Moxostoma anisurum				✓	✓	✓			✓		1,2,3,4,11,13,17,20,21
Moxostoma atripinne											1
Moxostoma aureolum											4
Moxostoma breviceps		✓									13,17
Moxostoma carinatum					✓	✓			✓		1,2,3,5,13,17,18,20,21
Moxostoma duquesni	✓	✓	✓	✓	✓				✓		1,2,3,4,9,11,13,14,15,17,18,20,21,25
Moxostoma erythrurum	✓	✓	✓	✓	✓	✓	✓		✓	✓	1,2,3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,20,21,22,25
Moxostoma macro-lepidotum brevic						✓					2,3,
Moxostoma macro-lepidotum m.					✓	✓			✓		1,2,8,11,13,18,19,20,21,22
Moxostoma rhothroecum						✓					2,3
Moxostoma rubreques											4
Nocomis biguttatus				✓							1,4,7,20
Nocomis effusus											1
Nocomis leptocephalus						✓		✓			2,3
Nocomis micropogon				✓	✓	✓					1,2,3,4,20

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nocomis platyrhynchus																				
Notemigonus crysoleucas			✓		✓	✓								✓	✓	✓	✓	✓	✓	✓
Notropis albeolus																				
Notropis amnis																				
Notropis ardens			✓	✓	✓	✓	✓	✓	✓						✓	✓	✓			
Notropis ariommus			✓		✓				✓					✓						
Notropis atherinoides	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notropis blennius		✓	✓		✓		✓		✓		✓	✓	✓	✓	✓	✓	✓			
Notropis boops		✓	✓		✓	✓			✓					✓			✓			
Notropis buchanani					✓				✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
Notropis camurus	✓																			
Notropis cerasinus																				
Notropis chalybaeus																				
Notropis coccogenis		✓	✓																	
Notropis cornutus chrysocephalus			✓			✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓

APPENDIX C: (Cont'd.)

SPECIES	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	RIVER BASIN																			
Nocomis platyrhynchus																				
Notemigonus crysoleucas	✓	✓	✓	✓	✓	✓		✓	✓			✓				✓	✓	✓	✓	✓
Notropis albeolus																				
Notropis amnis						✓														
Notropis ardens																				
Notropis ariommus																				
Notropis atherinoides			✓	✓	✓			✓		✓			✓	✓		✓	✓	✓		✓
Notropis blennius					✓	✓										✓	✓		✓	
Notropis boops																✓	✓			✓
Notropis buchanani			✓													✓	✓			✓
Notropis camurus																				
Notropis cerasinus																				
Notropis chalybaeus						✓							✓							
Notropis coccogenis																				
Notropis cornutus chrysocephalus	✓	✓	✓			✓	✓	✓	✓	✓	✓				✓	✓	✓		✓	

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RIVER BASIN																			
Nocomis platyrhynchus																				
Notemigonus crysoleucas	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓		✓		✓	✓	✓	✓	
Notropis albeolus																				
Notropis amnis																			✓	✓
Notropis ardens											✓			✓						
Notropis ariommus											✓			✓						✓
Notropis atherinoides	✓	✓	✓	✓						✓	✓		✓	✓	✓			✓		✓
Notropis blennius	✓		✓						✓		✓			✓						✓
Notropis boops			✓					✓			✓	✓	✓	✓	✓	✓	✓	✓		
Notropis buchanani			✓																	
Notropis camurus																				
Notropis cerasinus																				
Notropis chalybaeus																				
Notropis coccogenis																				
Notropis cornutus chrysocephalus	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Nocomis platyrhynchus						✓		✓			2,3
Notemigonus crysoleucas	✓	✓		✓	✓	✓	✓		✓	✓	1,2,3,4,6,8,10,11,14,15,17,18,20,21,22,25
Notropis albeolus		✓				✓		✓			2,6
Notropis amnis	✓										4,11
Notropis ardens		✓		✓	✓	✓		✓			1,2,3,4,10,15,17,22
Notropis ariommus		✓		✓	✓	✓					1,2,4,6,12
Notropis atherinoides	✓	✓		✓	✓	✓	✓		✓		1,2,3,4,5,12,13,14,15,17,18,19,20,21,25
Notropis blennius	✓	✓		✓	✓		✓		✓		1,2,3,4,11,12,15,16,17,18,20,21,25
Notropis boops			✓	✓							1,4,12,14,15,17,18,20,22
Notropis buchanani					✓	✓					1,2,3,17,18,20,25
Notropis camurus											23
Notropis cerasinus						✓					2
Notropis chalybaeus											20
Notropis coccogenis						✓					1,2
Notropis cornutus chrysocephalus		✓	✓	✓	✓	✓		✓	✓	✓	1,2,3,4,5,6,9,10,11,12,13,14,15,16,17,18,21,22

APPENDIX C: (Cont'd.)

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	RIVER BASIN																			
Notropis deliciosu stramineus							✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notropis dorsalis																				
Notropis emiliae	✓										✓									
Notropis fumeus	✓				✓				✓											
Notropis galacturus		✓	✓							✓										
Notropis heterolepis		✓			✓										✓					
Notropis hudsonius																				
Notropis leudiodus		✓	✓		✓															
Notropis lutrensis	✓				✓						✓									
Notropis maculatus	✓																			
Notropis photogenis			✓		✓	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓
Notropis procne																				
Notropis rubellus		✓	✓		✓		✓		✓	✓	✓			✓		✓	✓			✓
Notropis rubricroceus																				
Notropis scabriceps																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Notropis deliciosu stramineus	✓																			
Notropis dorsalis			✓	✓	✓					✓	✓	✓		✓	✓	✓	✓			
Notropis emiliae			✓			✓										✓		✓		✓
Notropis fumeus			✓															✓	✓	✓
Notropis galacturus																				
Notropis heterolepis					✓	✓														
Notropis hudsonius			✓					✓								✓				
Notropis leudiodus																				
Notropis lutrensis			✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		
Notropis maculatus																				
Notropis photogenis	✓					✓														
Notropis procne																				
Notropis rubellus	✓	✓		✓	✓	✓	✓	✓	✓	✓					✓					
Notropis rubricroceus																				
Notropis scabriceps																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Notropis deliciosus stramineus	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓
Notropis dorsalis																				
Notropis emiliae											✓							✓		✓
Notropis fumeus			✓																	
Notropis galacturus																				
Notropis heterolepis				✓							✓									
Notropis hudsonius																				
Notropis leudiodus																				
Notropis lutrensis			✓																	
Notropis maculatus																				
Notropis photogenis				✓	✓			✓			✓	✓		✓	✓	✓	✓	✓		
Notropis procne																				
Notropis rubellus	✓			✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓
Notropis rubricroceus																				
Notropis scabriceps																				

APPENDIX C: (Cont'd.)

SPECIES	61	62	63	64	65	66	67	68	69	70	References
	RIVER BASIN										
Notropis deliciosu stramineus				✓		✓	✓				4,17
Notropis dorsalis											20
Notropis emiliae	✓	✓									1,4,11,14,18,20
Notropis fumeus											1,20
Notropis galacturus											1,2
Notropis heterolepis											1,4,11,15,17,20
Notropis hudsonius					✓						2,3,20
Notropis leudiodus											1,2
Notropis lutrensis											1,20
Notropis maculatus											1
Notropis photogenis		✓	✓	✓	✓						1,2,3,4,11,14,17,22
Notropis procne											2
Notropis rubellus		✓		✓	✓						1,2,3,4,6,9,11,12,14,17,18,20,21
Notropis rubricroceus											2
Notropis scabriceps											2,3

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Notropis shumardi											✓									
Notropis spilopterus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notropis stramineus						✓														
Notropis telescopus			✓																	
Notropis texanus																				
Notropis umbratilis			✓		✓		✓	✓						✓				✓	✓	
Notropis venustus											✓									
Notropis volucellus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notropis whipplei	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓		
Noturus elegans		✓			✓			✓												
Noturus eleutherus					✓	✓	✓		✓	✓	✓					✓	✓	✓	✓	
Noturus exilis		✓	✓		✓															
Noturus flavus			✓		✓	✓	✓	✓	✓						✓	✓	✓	✓	✓	✓
Noturus furiosus															✓	✓	✓	✓	✓	
Noturus gyrinus	✓		✓	✓	✓	✓						✓				✓	✓			

APPENDIX C: (Cont'd.)

SPECIES	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	RIVER BASIN																			
Notropis shumardi			✓													✓	✓	✓		
Notropis spilopterus	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓			✓	✓
Notropis stramineus			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notropis telescopus																				
Notropis texanus						✓														
Notropis umbratilis				✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notropis venustus																				
Notropis volucellus	✓		✓			✓			✓										✓	
Notropis whipplei						✓			✓								✓		✓	✓
Noturus elegans																				
Noturus eleutherus																✓		✓	✓	
Noturus exilis																✓	✓			
Noturus flavus	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	✓		✓		✓	
Noturus furiosus																				
Noturus gyrinus			✓	✓	✓	✓	✓						✓		✓	✓	✓	✓		✓

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Notropis shumardi	✓																			
Notropis spilopterus	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notropis stramineus	✓									✓	✓				✓					
Notropis telescopus																				
Notropis texanus																				
Notropis umbratilis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notropis venustus																				
Notropis volucellus	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Notropis whipplei	✓	✓		✓		✓	✓	✓		✓	✓		✓	✓	✓		✓	✓	✓	✓
Noturus elegans																				
Noturus eleutherus	✓			✓							✓									✓
Noturus exilis																				
Noturus flavus	✓			✓	✓	✓			✓	✓	✓		✓		✓		✓			✓
Noturus furiosus																				
Noturus gyrinus	✓	✓	✓	✓	✓									✓				✓		✓

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Notropis shumardi											1,4,20,25
Notropis spilopterus		✓	✓	✓	✓	✓	✓	✓	✓		1,2,3,4,5,8,9,10,11,14,15,16,17,18, 20,21,22,25
Notropis stramineus			✓	✓	✓		✓		✓		1,2,3,5,11,12,15,18,20,21,22,25
Notropis telescopus						✓		✓			1,2
Notropis texanus											20
Notropis umbratilis	✓	✓		✓	✓	✓				✓	1,2,3,4,5,6,9,10,11,12,14,15,17,20
Notropis venustus											1,10
Notropis volucellus	✓	✓	✓	✓	✓	✓	✓	✓	✓		1,2,3,4,12,14,15,17,22,25
Notropis whipplei		✓	✓	✓	✓	✓	✓				1,2,3,4,6,7,11,13,14,17,20,22
Noturus elegans											1,23
Noturus eleutherus				✓							1,4,17,20,22
Noturus exilis											1
Noturus flavus				✓	✓						1,3,4,5,8,11,12,15,17,18,20,22
Noturus furiosus											17
Noturus gyrinus					✓						1,3,4,9,11,14,17,20

APPENDIX C: (Cont'd.)

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	RIVER BASIN																			
Noturus hildebrandi	✓																			
Noturus insignis																				
Noturus miurus			✓		✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	
Noturus nocturnus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							
Noturus phaeus	✓																			
Noturus stigmosus					✓	✓	✓		✓	✓	✓									
Noturus trautmani																	✓			
Osmerus mordax																				
Parexoglossum laurae hubbsi															✓					
Perca flavescens									✓		✓	✓	✓	✓	✓		✓		✓	
Percina caprodes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Percina copelandi		✓	✓		✓		✓		✓	✓			✓	✓	✓				✓	
Percina crassa																				
Percina cymatotaenia					✓				✓											
Percina evides		✓			✓				✓	✓										

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Noturus hildebrandi																				
Noturus insignis																				
Noturus miurus	✓								✓										✓	✓
Noturus nocturnus												✓	✓	✓		✓	✓		✓	
Noturus phaeus																				
Noturus stigmosus									✓											
Noturus trautmani																				
Osmerus mordax																✓				
Parexoglossum laurae hubbsi																				
Perca flavescens	✓		✓			✓										✓				
Percina caprodes	✓	✓	✓		✓	✓			✓							✓	✓		✓	✓
Percina copelandi																				
Percina crassa																				
Percina cymatotaenia																				
Percina evides																				

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RIVER BASIN																			
Noturus hildebrandi																				
Noturus insignis																				
Noturus miurus	✓		✓	✓	✓			✓	✓	✓	✓		✓		✓		✓	✓	✓	✓
Noturus nocturnus			✓							✓										✓
Noturus phaeus																				
Noturus stigmosus																				
Noturus trautmani																				
Osmerus mordax	✓																			
Parexoglossum laurae hubbsi																				
Perca flavescens	✓													✓						
Percina caprodes	✓			✓	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓		
Percina copelandi	✓																			
Percina crassa																				
Percina cymatotaenia																				
Percina evides														✓						

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Noturus hildebrandi											24
Noturus insignis					✓	✓		✓			2,3
Noturus miurus	✓			✓	✓	✓					1,2,3,4,5,9,14,15,17,20,22
Noturus nocturnus				✓							1,4,20
Noturus phaeus											1,24
Noturus stigmosus											1,20
Noturus trautmani											
Osmerus mordax											20
Parexoglossum laurae hubbsi											17
Perca flavescens					✓	✓		✓	✓		1,2,3,4,11,17,18,20,21
Percina caprodes		✓		✓	✓	✓	✓		✓		1,2,3,4,5,6,8,10,11,12,13,14,15,17,18,20 21,22
Percina copelandi					✓	✓					1,2,3,4,17,24
Percina crassa						✓		✓			2
Percina cymatotaenia											1
Percina evides						✓					1,2,4,24

APPENDIX C: (Cont'd.)

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	RIVER BASIN																			
Percina macrocephala					✓		✓		✓	✓									✓	
Percina maculata	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓
Percina oxyrhyncha							✓		✓	✓				✓						
Percina phoxocephala	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	
Percina sciera			✓		✓			✓	✓	✓	✓						✓			
Percina shumardi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓		✓		✓	
Percina squamata		✓	✓																	
Percina uranidea	✓	✓	✓		✓															
Percopsis omiscomaycus					✓	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓	✓	
Phenacobius mirabilis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓		✓	
Phenacobius teretulus																				
Phenacobius uranops		✓	✓		✓															
Pimephales notatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pimephales promelas	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓				
Pimephales vigilax		✓	✓							✓				✓		✓	✓	✓	✓	

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Percina macrocephala																				
Percina maculata	✓	✓		✓		✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Percina oxyrhyncha																				
Percina phoxocephala			✓	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓		✓	✓
Percina sciera						✓			✓										✓	✓
Percina shumardi			✓													✓	✓	✓		
Percina squamata																				
Percina uranidea																				
Percopsis omiscomaycus																✓				
Phenacobius mirabilis			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Phenacobius teretulus																				
Phenacobius uranops																				
Pimephales notatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pimephales promelas				✓	✓	✓		✓			✓	✓	✓	✓	✓	✓	✓		✓	
Pimephales vigilax		✓	✓	✓	✓	✓	✓	✓	✓			✓	✓			✓	✓	✓	✓	✓

APPENDIX C: (Cont'd.)

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	RIVER BASIN																			
Percina macrocephala																				
Percina maculata	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓
Percina oxyrhyncha																				
Percina phoxocephala	✓		✓		✓	✓				✓	✓			✓				✓		✓
Percina sciera	✓			✓						✓	✓							✓		✓
Percina shumardi	✓																			✓
Percina squamata																				
Percina uranidea																				
Percopsis omiscomaycus																				
Phenacobius mirabilis	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Phenacobius teretulus																				
Phenacobius uranops																				
Pimephales notatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pimephales promelas	✓					✓	✓			✓						✓		✓		✓
Pimephales vigilax	✓	✓	✓						✓	✓			✓	✓	✓			✓	✓	✓

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 61	62	63	64	65	66	67	68	69	70	References
Percina macrocephala					✓	✓					1,2,3,17
Percina maculata				✓	✓	✓		✓		✓	1,2,3,4,5,11,12,14,17,18,20,22
Percina oxyrhyncha					✓	✓		✓	✓		2,23
Percina phoxocephala	✓				✓						1,2,3,4,8,11,14,17,20,22
Percina sciera					✓	✓					1,2,3,4,11,14,15,17,20
Percina shumardi											1,4,17,20
Percina squamata											1
Percina uranidea											1
Percopsis omiscomaycus				✓	✓	✓			✓		1,2,3,4,17,20,21,23
Phenacobius mirabilis	✓		✓	✓	✓	✓					1,2,3,4,5,9,10,11,14,15,16,17,20,22
Phenacobius teretulus						✓		✓			2,3
Phenacobius uranops											1
Pimephales notatus	✓		✓	✓	✓	✓	✓	✓	✓	✓	1,2,3,4,5,6,7,8,9,10,12,13,14,15,16,17,18,20,21,22,25
Pimephales promelas				✓	✓	✓	✓	✓			1,2,3,4,7,11,12,14,17,20,22
Pimephales vigilax	✓				✓	✓					1,2,3,4,7,11,14,17,20

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Polyodon spathula		✓	✓		✓			✓	✓		✓	✓	✓	✓			✓			
Pomoxis annularis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pomoxis nigromaculatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
Pungitius pungitius																				
Pylodictis olivarus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Rhinichthys atratulus			✓												✓	✓	✓	✓	✓	✓
Rhinichthys cataractae																				
Salmo gairdneri			✓		✓															
Salmo trutta																				
Salvelinus fontinalis															✓					
Scaphirhynchus alba																				
Scaphirhynus platorynchus											✓	✓	✓	✓						
Semotilus atromaculatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓
Semotilus margarita																				
Stizostedion canadense	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

APPENDIX C: (Cont'd.)

SPECIES	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
	RIVER BASIN																			
Polyodon spathula			✓	✓												✓	✓	✓		✓
Pomoxis annularis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pomoxis nigromaculatus	✓	✓	✓		✓	✓		✓			✓	✓				✓	✓	✓	✓	✓
Pungitius pungitius																✓				
Pylodictis olivarus	✓		✓						✓	✓		✓		✓		✓	✓		✓	✓
Rhinichthys atratulus	✓	✓		✓	✓	✓		✓								✓				
Rhinichthys cataractae																				
Salmo gairdneri						✓		✓												
Salmo trutta						✓														
Salvelinus fontinalis																				
Scaphirhynchus alba			✓																	
Scaphirhynus platorynchus			✓						✓								✓			
Semotilus atromaculatus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Semotilus margarita																				
Stizostedion canadense			✓		✓				✓				✓			✓	✓	✓	✓	✓

APPENDIX C: (Cont'd.)

RIVER BASIN

SPECIES	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Polyodon spathula	✓																			
Pomoxis annularis	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Pomoxis nigromaculatus	✓	✓	✓	✓	✓				✓	✓	✓			✓				✓	✓	✓
Pungitius pungitius																				
Pylodictis olivarus	✓			✓						✓	✓				✓			✓		
Rhinichthys atratulus	✓			✓	✓	✓		✓			✓			✓		✓				
Rhinichthys cataractae																				
Salmo gairdneri	✓																			
Salmo trutta																				
Salvelinus fontinalis																				
Scaphirhynchus alba																				
Scaphirhynus platorynchus	✓													✓						
Semotilus atromaculatus	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Semotilus margarita																				
Stizostedion canadense	✓			✓						✓	✓				✓					

APPENDIX C: (Cont'd.)

SPECIES	61	62	63	64	65	66	67	68	69	70	References
	RIVER BASIN										
Polyodon spathula					✓	✓					1,2,3,17,20,25
Pomoxis annularis	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1,2,3,4,5,8,10,11,14,15,16,17,18,19,20,21 22,25
Pomoxis nigromaculatus	✓				✓	✓	✓		✓		1,2,3,4,8,9,11,13,14,15,17,18,19,20,25
Pungitius pungitius											20
Pylodictis olivarus					✓	✓		✓	✓		1,2,3,5,8,14,15,17,18,19,20,21,22,25
Rhinichthys atratulus				✓	✓	✓		✓			1,2,3,4,9,11,12,15,17,20
Rhinichthys cataractae					✓	✓		✓			2,3
Salmo gairdneri					✓	✓					1,2,3,20
Salmo trutta					✓	✓					2,3,11
Salvelinus fontinalis					✓	✓					2,3,17
Scaphirhynchus alba											20
Scaphirhynus platorynchus					✓						1,2,3,4,20
Semotilus atromaculatus	✓	✓	✓	✓	✓	✓		✓	✓	✓	1,2,3,4,5,6,9,10,11,12,14,15,16,17,18, 20,21,22,25
Semotilus margarita					✓						3
Stizostedion canadense					✓	✓					1,2,3,4,5,8,13,15,17,18,19,20,22

APPENDIX C: (Cont'd.)

SPECIES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	RIVER BASIN																			
Stizostedion vitreum	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Typhlichthys subterraneus					✓															
Umbra limi																				

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN																			
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Stizostedion vitreum			✓		✓	✓										✓	✓	✓		
Typhlichthys subterraneus																				
Umbra limi					✓	✓		✓								✓		✓		

APPENDIX C: (Cont'd.)

SPECIES	RIVER BASIN 41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Stizostedion vitreum	✓			✓																
Typhlichthys subterraneus																				
Umbra limi	✓		✓	✓	✓													✓	✓	

APPENDIX C: (Cont'd.)

SPECIES	61	62	63	64	65	66	67	68	69	70	References
Stizostedion vitreum					✓	✓			✓		1,2,3,4,8,11,17,18,20,21
Typhlichthys subterraneus											1
Umbra limi										✓	4,9,11,14,17,20

River: Obion Creek and Bayou du Chien

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carp sucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Centrarchus macropterus	Flier	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Elassoma zonatum	Banded pygmy sunfish	L
Erimyzon oblongus	Creek chubsucker	D
Erimyzon sucetta	Lake chubsucker	L
Esox americanus vermiculatus	Grass pickerel	D
Esox niger	Chain pickerel	L
Etheostoma asprigene	Mud darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma gracile	Slough darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma parvipinne	Goldstripe darter	L
Etheostoma proeliare	Cypress darter	L
Etheostoma swaini	Gulf darter	I
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Fundulus olivaceus	Blackspotted topminnow	L
Gambusia affinis	Mosquitofish	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybognathus hayi	Cypress minnow	L
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis gracilis	Flathead chub	L
Hybopsis storeriana	Silver chub	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D

Obion Creek and Bayou de Chien (Cont'd.)

Species	Common Name	Status
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepisosteus spatula	Alligator gar	L
Lepomis cyanellus	Green sunfish	U
Lepomis gulosis	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis marginatus	Dollar sunfish	I
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Lepomis punctatus	Spotted sunfish	L
Lepomis symmetricus	Bantam sunfish	L
Menidia audens	Mississippi silverside	L
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum breviceps	Southern shorthead redhorse	L
Notropis atherinoides	Emerald shiner	D
Notropis camurus	Bluntnose shiner	I
Notropis emiliae	Pugnose minnow	D
Notorpis fumeus	Ribbon shiner	L
Notropis lutrensis	Redshiner	D
Notropis maculatus	Taillight shiner	I
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus gyrinus	Tadpole madtom	D
Noturus hildebrandi	Least madtom	I
Noturus nocturnus	Freckled madtom	D
Noturus phaeus	Brown madtom	I
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Sharpnose darter	D
Percina shumardi	River darter	D
Percina uranidea	Stargazing darter	L
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U

Obion Creek and Bayou de Chien (Cont'd.)

Species	Common Name	Status
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Tennessee

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Centrarchus macropterus	Flier	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Erimyzon oblongus	Creek chubsucker	D
Erimyzon sucetta	Lake chubsucker	L
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma asprigene	Mud darter	D
Etheostoma cinereum	Ashy darter	L
Etheostoma flabellare	Fantail darter	D
Etheostoma histrio	Harlequin darter	L
Etheostoma neopterum	Lollipop darter	I
Etheostoma nigrum	Johnny darter	U
Etheostoma parvipinne	Goldstripe darter	L
Etheostoma proeliare	Cypress darter	L
Etheostoma rufilineatum	Redline darter	L
Etheostoma squamiceps	Spottail darter	L
Etheostoma stigmaeum	Speckled darter	L
Etheostoma tippecanoe	Tippecanoe darter	D
Fundulus catenatus	Northern studfish	L
Fundulus notatus	Blackstripe topminnow	D
Fundulus olivaceus	Blackspotted topminnow	L
Gambusia affinis	Mosquito fish	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis insignis	Blotched chub	L
Hybopsis storeriana	Silver chub	D
Ichthyomyzon castaneus	Chestnut lamprey	L
Ichthyomyzon fossor	Northern brook lamprey	L
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D

Tennessee (Cont'd.)

Species	Common name	Status
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone mississippiensis	Yellow bass	L
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis coccogenis	Warpaint shiner	L
Notropis galacturus	Whitetail shiner	L
Notropis heterolepis	Blacknose shiner	L
Notropis leuciodus	Tennessee shiner	L
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus elegans	Elegant madtom	L
Noturus exilis	Slender madtom	L
Noturus nocturnus	Freckled madtom	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina evides	Gilt darter	L
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina shumardi	River darter	D
Percina squamata	Olive darter	L
Percina uranidea	Stargazing darter	L
Phenacobius mirabilis	Suckermouth minnow	U
Phenacobius uranops	Stargazing minnow	L
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Polyodon spatula	Paddlefish	D

Tennessee (Cont'd.)

Species	Common name	Status
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Cumberland

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Centrarchus macropterus	Flier	D
Chologaster agassizi	Karst springfish	L
Clinostomus funduloides	Rosyside dace	L
Cottus carolinae	Banded sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Erimyzon oblongus	Creek chubsucker	D
Erimyzon sucetta	Lake chubsucker	L
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma asprigene	Mud darter	D
Etheostoma atripinne	Snubnose darter	L
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma cinereum	Ashy darter	L
Etheostoma flabellare	Fantail darter	D
Etheostoma kennicotti	Stripetail darter	L
Etheostoma maculatum	Spotted darter	L
Etheostoma microlepidum	Smallscale darter	I
Etheostoma nigrum	Johnny darter	D
Etheostoma obeyense	Barcheek darter	I
Etheostoma proeliare	Cypress darter	L
Etheostoma rufilineatum	Redline darter	L
Etheostoma sagitta	Arrow darter	L
Etheostoma spectabile	Orangethroat darter	D
Etheostoma stigmaeum	Speckled darter	L
Etheostoma tippecanoe	Tippecanoe darter	D
Etheostoma virgatum	Striped darter	L
Etheostoma zonale	Banded darter	D
Fundulus catenatus	Northern studfish	L
Fundulus notatus	Blackstripe topminnow	D
Fundulus olivaceus	Blackspotted topminnow	L
Gambusia affinis	Mosquitofish	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybopsis aestivalis	Speckled chub	D

Cumberland (Cont'd.)

Species	Common name	Status
Hybopsis dissimilis	Streamline chub	D
Hybopsis insignis	Blotched chub	L
Hybopsis storeriana	Silver chub	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon castaneus	Chestnut lamprey	L
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D
Lampetra lamottei	American brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Lepomis punctatus	Spotted sunfish	L
Micropterus coosae	Redeye bass	I
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone mississippiensis	Yellow bass	L
Morone saxatilis	Striped bass	L
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis effusus	Redtail chub	L
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefin shiner	D
Notropis ariommus	Popeye shiner	L
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis coccogenis	Warpoint shiner	L
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis galacturus	Whitetail shiner	L
Notropis leuciodus	Tennessee shiner	L
Notropis photogenis	Silver shiner	D

Cumberland (Cont'd.)

Species	Common name	Status
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis telescopus	Telescope shiner	L
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus exilis	Slender madtom	L
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Percina shumardi	River darter	D
Percina squamata	Olive darter	L
Percina uranidea	Stargazing darter	L
Phenacobius mirabilis	Suckermouth minnow	U
Phenacobius uranops	Stargazing minnow	L
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Polyodon spatula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Salmo gairdneri	Rainbow trout	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Tradewater

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Ambloplites rupestris	Rock bass	U
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Centrarchus macropterus	Flier	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Erimyzon sucetta	Lake chubsucker	L
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma gracile	Slough darter	D
Etheostoma nigrum	Johnny darter	U
Fundulus notatus	Blackstripe topminnow	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis storeriana	Silver chub	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosis	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D

Tradewater (Cont'd.)

Species	Common name	Status
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notropis ardens	Ohio rosefin shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus gyrinus	Tadpole madtom	D
Noturus nocturnus	Freckled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina shumardi	River darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Green

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Centrarchus macropterus	Flier	D
Cottus carolinae	Banded sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Erimyzon oblongus	Creek chubsucker	D
Erimyzon sucetta	Lake chubsucker	L
Esox americanus vermiculatus	Grass pickerel	D
Esox masquinongy	Muskellunge	L
Etheostoma asprigene	Mud darter	D
Etheostoma atripinne	Snubnose darter	L
Etheostoma bellum	Orangefin darter	I
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma gracile	Slough darter	D
Etheostoma kennicotti	Stripetail darter	L
Etheostoma maculatum	Spotted darter	L
Etheostoma microperca	Least darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma squamiceps	Spottail darter	L
Etheostoma stigmaeum	Speckled darter	L
Etheostoma virgatum	Striped darter	L
Etheostoma zonale	Banded darter	D
Fundulus catenatus	Northern studfish	L
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis dissimilis	Streamline chub	D
Hybopsis insignis	Blotched chub	L

Green (Cont'd.)

Species	Common name	Status
Hybopsis storeriana	Silver chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon fossor	Northern brook lamprey	L
Ichthyomyzon greeleyi	Allegheny brook lamprey	L
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D
Lampetra lamottei	American brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosis	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone saxatilis	Striped bass	L
Moxostoma anisurum	Silver redhorse	D
Moxostoma atripinne	Blackfin sucker	I
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis effusus	Redtail chub	L
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefin shiner	D
Notropis ariommus	Popeye shiner	L
Notropis atherinoides	Emerald shiner	D
Notropis bleunnius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis buchanani	Ghost shiner	D
Notropis fumeus	Ribbon shiner	L
Notropis heterolepis	Blacknose shiner	L
Notropis leuciodus	Tennessee shiner	L
Notropis lutrensis	Redshiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D

Green (Cont'd.)

Species	Common name	Status
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus elegans	Elegant madtom	L
Noturus eleutherus	Mountain madtom	D
Noturus exilis	Slender madtom	L
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Noturus stigmosus	Northern madtom	L
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina cymatotaenia	Bluestripe darter	L
Percina evides	Gilt darter	L
Percina macrocephala	Longhead darter	L
Percina maculatoa	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Percina shumardi	River darter	D
Percina uranidea	Stargazing darter	L
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Phenacobius uranops	Stargazing minnow	L
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Polyodon spatula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Salmo gairdneri	Rainbow trout	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D
Typhlichthys subterraneus	Lesserblindfish	I

River: Salt

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Amblyopsis spelaea	Mammoth cave blindfish	I
Amia calva	Bowfin	D
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chologaster agassizi	Karst springfish	L
Chrosomus erythrogaster	Southern redbelly dace	D
Cottus carolinae	Banded sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Esox masquinongy	Muskellunge	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma microperca	Least darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Ehteostoma zonale	Banded darter	D
Fundulus catenatus	Northern studfish	L
Fundulus notatus	Blackstripe topminnow	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis amblops	Bigeye chub	D
Hybopsis storeriana	Silver chub	D
Hypentelium nicricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Icththyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D
Lepisosteus osseus	Longnose gar	D

Salt (Cont'd.)

Species	Common name	Status
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis cyanellus x humilis	Hybrid sunfish	I
Lepomis cyanellus x megalotis	Hybrid sunfish	I
Lepomis humilis	Orangespotted sunfish	D
Lepomis humilis x macrochirus	Hybrid sunfish	I
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefin shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis photogenis	Silver shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Noturus stigmosus	Northern madtom	L
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina shumardi	River darter	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annualris	White crappie	U

Salt (Cont'd.)

Species	Common Name	Status
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Licking

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Clinostomus elongatus	Redside dace	L
Cottus bairdi	Mottled sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Esox masquinongy	Muskellunge	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma kennicotti	Stripetail darter	L
Etheostoma maculatum	Spotted darter	l
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma tippecanoe	Tippecanoe darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Hiodon alosoides	Goldeye	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis storeriana	Silver chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bedellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D

Licking (Cont'd.)

Species	Common name	Status
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Lota lota lacustris	American burbot	L
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis micropogon	River chub	D
Notropis ardens	Ohio rosefin shiner	D
Notropis atherinoides	Emerald shiner	D
Notorpis blennius	River shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Noturus stigmosus	Northern madtom	L
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina macrocephala	Longhead darter	L
Percina maculata	Blackside darter	U
Percina oxyrhyncha		L
Percina phoxocephala	Slenderhead darter	D
Percina shumardi	River darter	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Little Sandy

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Carp	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Clinostomus funduloides	Rosyside dace	L
Cottus bairdi	Mottled sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Esox americanus vermiculatus	Grass pickerel	D
Esox masquinongy	Muskellunge	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma variatum	Varigate darter	D
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Hiodon alosoides	Goldeye	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis storeriana	Silver chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra lamottei	American brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D

Little Sandy (Cont'd.)

Species	Common name	Status
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis micropogon	River chub	D
Notropis ardens	Ohio rosefin shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis photogenis	Silver shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus elegans	Elegant madtom	L
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Percina shumardi	River darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Polyodon spatula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Kentucky

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cottus carolinae	Banded sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Esox americanus vermiculatus	Grass pickerel	D
Esox masquinongy	Muskellunge	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma maculatum	Spotted darter	L
Etheostoma nigrum	Johnny darter	U
Etheostoma sagitta	Arrow darter	L
Etheostoma spectabile	Orangethroat darter	D
Etheostoma tippecanoe	Tippecanoe darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Fundulus catenatus	Northern studfish	L
Fundulus notatus	Blackstripe topminnow	D
Hiodon alosoides	Goldeye	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis dissimilis	Streamline chub	D
Hybopsis storeriana	Silver chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon fossor	Northern brook lamprey	L
Ichthyomyzon greeleyi	Allegheny brook lamprey	L
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead catfish	U
Ictalurus natalis	Yellow bullhead catfish	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D

Kentucky (Cont'd.)

Species	Common name	Status
Lampetra lamottei	American brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomus biguttatus	Horneyhead chub	D
Nocomis micropogon	River chub	D
Notropis ardens	Ohio rosefin shiner	D
Notropis ariommus	Popeye shiner	L
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis fumeus	Ribbon shiner	L
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eletherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Noturus stigmosus	Northern madtom	L
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina cymatotaenia	Bluestripe darter	L
Percina evides	Gilt darter	L
Percina macrocephala	Longhead darter	L
Percina maculata	Blackside darter	U

Kentucky (Cont'd.)

Species	Common name	Status
Percina oxyrhyncha	Slenderhead darter	L
Percina phoxocephala	Sharpnose darter	D
Percina sciera	Dusky darter	D
Percina shumardi	River darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Polyodon spatula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Big Sandy

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Clinostomus funduloides	Rosyside dace	L
Cottus bairdi	Mottled sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroated darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Hiodon alosoides	Goldeye	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis dissimilis	Streamline chub	D
Hybopsis storeriana	Silver chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon fossor	Northern brook lamprey	L
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D
Lampetra lamottei	American brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D

Big Sandy (Cont'd.)

Species	Common name	Status
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Goldern redhorse	U
Nocomis micropogon	River chub	D
Notropis atherinoides	Emerald shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis galacturus	WHitetail shiner	L
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Noturus stigmosus	Northern madtom	L
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina evides	Gilt darter	L
Percina macrocephala	Longhead darter	L
Percina maculata	Blackside darter	U
Percina oxyrhyncha		L
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Percina shumardi	River darter	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	ED

River: Lower Ohio

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Cottus carolinae	Banded sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Erimyzon sucetta	Lake chubsucker	L
Esox americanus vermiculatus	Grass pickerel	D
Esox niger	Chain pickerel	L
Etheostoma caeruleum	Rainbow darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma gracile	Slough darter	D
Ehteostoma kennicotti	Stripetail darter	L
Etheostoma proeliare	Cypress darter	L
Fundulus olivaceus	Blackspotted topminnow	L
Gambusia affinis	Mosquito fish	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybognathus hayi	Cypress minnow	L
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus catus	White catfish	L
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D

Lower Ohio (Cont'd.)

Species	Common name	Status
Lepisosteus oculatus	Spotted gar	L
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepisosteus spatula	Alligator gar	L
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Lota lota lacustris	American burbot	L
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone mississippiensis	Yellow bass	L
Morone saxatilis	Stirped bass	L
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis buchanani	Ghost shiner	D
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis emiliae	Pugnose minnow	D
Notropis lutrensis	Redshiner	D
Notropis rubellus	Rosyface shiner	D
Notropis shumardi	Silverband shiner	L
Notropis spilopterus	Spotfin shiner	U
Notropis venustus	Blacktail shiner	I
Notropis volucellus	Mimic shiner	U
Noturus eleutherus	Mountain madtom	D
Noturus nocturnus	Freckled madtom	D
Noturus stigmosus	Northern madtom	L
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina sciera	Dusky darter	D
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Polyodon spatula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Scaphirhynus platorynchus	Shovelnose sturgeon	L
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Middle Ohio

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Esox american vermiculatus	Grass pickerel	D
Etheostoma microperca	Least darter	D
Fundulus notatus	Blackstripe topminnow	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus catus	White catfish	L
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepisosteus spatula	Alligator gar	L
Lepomis cyanellus	Green sunfish	U
Lepomis gibbosus	Pumpkinseed	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Lota lota lacustris	American burbot	L

Middle Ohio (Cont'd.)

Species	Common name	Status
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone saxatilis	Striped bass	L
Moxostoma breviceps	Ohio redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum breviceps	Southern shorthead redhorse	L
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis buchanani	Ghost shiner	D
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Noturus gyrinus	Tadpole madtom	D
Noturus nocturnus	Freckled madtom	D
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina shumardi	River darter	D
Percopsis omiscomaycus	Troutperch	D
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Polyodon spatula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Scaphirhynus platorynchus	Shovelnose sturgeon	L
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Upper-Mid Ohio

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Alosa pseudoharengus	Alewife	L
Ambloplites rupestris	Rock bass	U
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwate drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Chaenobryttus gulosus	Warmouth	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Esox americanus vermiculatus	Grass pickerel	D
Hiodon alosoides	Goldeye	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepisosteus spatula	Alligator gar	L
Lepomis cyanellus	Green sunfish	U
Lepomis gibbosus	Pumpkinseed	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma breviceps	Ohio redhorse	D

Upper-Mid Ohio (Cont'd.)

Species	Common name	Status
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis buchanani	Ghost shiner	D
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Noturus nocturnus	Freckled madtom	D
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percopsis omiscomaycus	Troutperch	D
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Polyodon spatula	Paddlefish	D
Pomolobus chrysochloris	Skipjack herring	L
Pomoxis annularis	White crappie	U
Pomixis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Scaphirhynus platorynchus	Shovelnose sturgeon	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Upper Ohio

Species	Common name	Status
Acipenser fulvescens	Lake sturgeion	D
Alosa chrysochloris	Skipjack herring	D
Ambloplites ruperstris	Rock bass	U
Anguilla rostrata	American eel	D
Aplodinoturs grunniens	Freshwater drum	D
CAmpostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Chaenobrytus gulosus	Warmouth	D
Clinostomus elongatus	Redside dace	L
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Ericymba buccata	Silverjaw minnow	D
Ehteostoma caeruleum	Rainbow darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma variatum	Variegate darter	L
Etheostoma zonale	Banded darter	D
Fundulus diaphanus	Banded killifish	L
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybopsis aestivalis S	Speckled chub	D
Hybopsis amblops	Bigeye chub	D
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata		
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus catus	White catfish	L
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Lampetra aegyptera	Least brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibbosus	Pumpkinseed	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D

Upper Ohio (Cont'd.)

Species	Common name	Status
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone saxatilis	Striped bass	L
Moxostoma anisurum	Silver redhorse	D
Moxostoma breviceps	Ohio redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma m. macrolepidotum	Northern shorthead redhorse	D
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus miurus	Brindled madtom	D
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina maculata	Blackside darter	U
Percina oxyrhyncha		L
Percina phoxocephala	Slenderhead darter	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Polyodon spatula	Paddlefish	D
Pomolobus chrysochloris	Skipjack herring	L
Pomoxis annualris	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Scaphirhyncus platorynchus	Shovelnose sturgeion	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Great Miami

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	U
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Clinostomus elongatus	Redside dace	L
Cottus bairdi	Mottled sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	L
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma microperca	Least darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Eucalia inconstans	Brook stickleback	L
Hybopsis amblops	Bigeye chub	D
Hybopsis micropogon	River chub	L
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Lepomis cyanellus	Green sunfish	U
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma breviceps	Ohio redhorse	U
Moxostoma carinatum	River redhorse	D
Moxostoma erythrurum	Golden redhorse	U

Great Miami (Cont'd.)

Species	Common name	Status
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefine shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis heterolepis	Blacknose shiner	L
Notropis photogenis	Silver shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Notorpis whipplei	Steelcolor shiner	D
Noturus flavus	Stonecat	D
Noturus furiosus	Northern madtom	L
Noturus miurus	Brindled madtom	D
Parexoglossum laurae hubbsi	Western tonguetied chub	I
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina shumardi	River darter	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annularis	WHite crappie	U
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Salvelinus fontinalis	Brook trout	L
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Little Miami

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chaenobryttus gulosus	Warmouth	D
Chrosomus erythrogaster	Southern redbelly dace	D
Cycleptus elongatus	Blue sucker	D
Cyrpinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma exile	Iowa darter	L
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibbosus	Pumpkinseed	L
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Moxostoma anisurum	Silver redhorse	D
Moxostoma breviceps	Ohio redhorse	D
Moxostoma carinatum	River redhorse	D

Little Miami (Cont'd.)

Species	Common name	Status
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefin shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus furiosus	Northern madtom	L
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Roccus chrysops	White bass	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Scioto

Species	Common name	Status
Acipenser fulvescens	Lake sturgeion	D
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Clinostomus elongatus	Redside dace	L
Clinostomus vandoisulus	Rosy dace	I
Cottus bairdi	Mottled sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Erimyzon sucetta	Lake chubsucker	L
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma flabellare	Fatail darter	D
Etheostoma maculatum	Spotted darter	L
Etheostoma microperca	Least darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma tippecanoe	Tippecanoe darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybopsis amblops	Bigeye chub	D
Hybopsis biguttata	Horneyhead chub	L
Hybopsis dissimilis	Streamline chub	D
Hybopsis micropogon	River chub	L
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon fossor	Northern brook lamprey	L
Ichthyomyzon unicuspis	Silver lamprey	D

Scioto (Cont'd.)

Species	Common name	Status
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma breviceps	Ohio redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Goldern redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefin shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	
Noturus furiosus	Northern madtom	L
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Noturus trautmani	Scioto madtom	I
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D

Scioto (Cont'd.)

Species	Common name	Status
Percina maculata	Blackside darter	U
Percina phoxocephala	Sharpnose darter	D
Percina sciera	Dusky darter	D
Percina shumardi	River darter	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Polyodon spatula	Paddlefish	D
Pomolobus chrysochloris	Skipjack herring	L
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodicits olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Roccus chrysops	White bass	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Hocking

Specis	Common name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Aplodinotus grunniens	Freshwater drum	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Cyrpinus carpio	Carp	U
Dorsoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis amblops	Bigeye chub	D
Hybopsis micropogon	River chub	L
Hybopsis x-punctata	Gravel chub	D
Hypentelium nigricans	Northern hog sucker	D
Ictalurus melas	Black bullhead	U
Ictalurus punctatus	Channel catfish	U
Labidesthes sicculus	Brook silverside	D
Lepisosteus osseus	Longnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibbosus	Pumpkinseed	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma breviceps	Ohio redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U

Hocking (Cont'd.)

Species	Common name	Status
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus furiosus	Northern madtom	L
Noturus miurus	Brindled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percopsis omiscomaycus	Troutperch	D
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Muskingum

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chaenobryttus gulosis	Warmouth	D
Chrosomus erythrogaster	Southern redbelly dace	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Esox americanus vermiculatus	Grass pickerel	D
Esox niger	Chain pickerel	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma exile	Iowa darter	L
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma tippecanoe	Tippecanoe darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Eucalia inconstans	Brook stickleback	L
Hybopsis aestivalis	Speckled chub	D
Hybopsis amblops	Bigeye chub	D
Hybopsis dissimilis	Streamline chub	D
Hybopsis micropogon	River chub	L
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictobus cyprinellus	Bigmouth buffalo	D
Lepisosteus osseus	Longnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U

Muskingum (Cont'd.)

Species	Common name	Status
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma breviceps	Ohio redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emeral shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus furiosus	Northern madtom	L
Noturus miurus	Brindled madtom	D
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina macrocephala	Longhead darter	L
Percina maculata	Blackside darter	U
Percina phoxocephala	Sharpnose darter	D
Percina shumardi	River darter	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Roccus chrysops	White bass	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Big Yellow Creek

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
CAmpostoma anomalum	Stoneroller	U
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Clinostomus elongatus	Redside dace	L
Cyprinus carpio	Carp	U
Ericymba buccata	Silverjaw minnow	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma variatum	Variegate darter	D
Ehteostoma zonale	Banded darter	D
Fundulus diaphanus	Banded killifish	L
Hybopsis amblops	Bigeye chub	D
Hybopsis micropogon	River chub	L
Hypentelium nigricans	Northern hog sucker	D
Ictalurus melas	Black bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Lepomis cyanellus	Green sunfish	U
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notorpis atherinoides	Emerald shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Noturus flavus	Stonecat	D
Percina maculata	Blackside darter	U
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U

River: Little Beaver Creek

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Anguilla rostrata	American eel	D
Campostoma anomalum	Stoneroller	U
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	WHite sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Clinostomus elongatus	Redside dace	L
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma variatum	Varigate darter	D
Etheostoma zonale	Banded darter	D
Eucalia inconstans	Brook stickleback	L
Hybopsis amblops	Bigeye chub	D
Hybopsis micropogon	River chub	L
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon greeleyi	Allegheny brook lamprey	L
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Lepomis cyanellus	Green sunfish	U
Lepomis gibbosus	Pumpkinseed	D
Lepomis macrochirus	Bluegill	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Moxostoma breviceps	Ohio redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis cornutus chrysoleucas	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis volucellus	Mimic shiner	U
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina maculata	Blackside dace	U
Pimephales notatus	Bluntnose minnow	U

Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U

River: Mahoning

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Catostomus commersoni	WHite sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Clinostomus elongatus	Redside dace	L
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Eucalia inconstans	Brook stickleback	L
Hybopsis micropogon	River chub	L
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon greeleyi	Allegheny brook lamprey	L
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosis	Warmouth	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Morone chrysops	White bass	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Noturus flavus	Stonecat	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U

River: Mississippi

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa alabamae	Alabama shad	L
Alosa chrysochloris	Skipjack herring	D
Amia calva	Bowfin	D
Ammocrypta clara	Western sand darter	D
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	Rivercarpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Cottus carolinae	BAnded sculpin	D
Ctenopharyngodon idella	Grass carp	I
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dionda nubila	Ozark minnow	L
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Ericymba buccata	Silverjaw minnow	D
Esox americanus vermiculatus	Grass pickerel	D
Esox lucius	Northern pike	L
Etheostoma asprigene	Mud darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus catenatus	Northern studfish	L
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybognathus argyritis	Western silvery minnow	L
Hybognathus nuchalis	Silvery minnow	D
Hybognathus placitus	Plains minnow	I
Hybopsis aestivalis	Speckled chub	D
Hybopsis gelida	Sturgeon chub	I
Hybopsis gracilis	Flathead chub	L
Hybopsis meeki	Sicklefin chub	I
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Ichthyomyzon castaneus	Chestnut lamprey	L
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus catus	White catfish	L
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U

Mississippi (Cont'd.)

Species	Common name	Status
Ictalurus punctatus	Channel catfish	U
Ictiobus Bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepisosteus oculatus	Spotted gar	L
Lipisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepisosteus spatula	Alligator gar	L
Lepomis cyanellus	Green sunfish	U
Lepomis gulosis	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lota lota lacustris	American burbot	L
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone mississippiensis	Yellow bass	L
Moxostoma erythrurum	Golden redhorse	U
Moxostoma m. macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis dorsalis	Bigmouth shiner	L
Notropis emiliae	Pugnose minnow	D
Notropis fumeus	Ribbon shiner	L
Notropis hudsonius	Spottail shiner	L
Notropis lutrensis	Redshiner	D
Notropis shumardi	Silverband shiner	L
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis volucellus	Mimic shiner	U
Noturus gyrinus	Tadpole madtom	D
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina phoxocephala	Slenderhead darter	D
Percina shumardi	River darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Polyodon spatula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D

Mississippi (Cont'd.)

Species	Common name	Status
Pylodictis olivarus	Flathead catfish	D
Scaphirhynchus alba	Pallid sturgeon	I
Scaphirhynchus platorynchus	Shovelnose sturgeion	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Green River in Illinois

Species	Common name	Status
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma nigrum	Johnny darter	U
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hiodon tergius	Mooneye	D
Hypentelium nigricans	Northern hog sucker	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Moxostoma erythrurum	Goldern redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis dorsalis	Bigmouth shiner	L
Notropis lutrensis	Redshiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Polyodon spatula	Paddlefish	D
Pomoxis annularis	White crappie	U
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U

River: Rock River

Species	Common name	Status
Ambloplites rupestris	Rock Bass	U
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater Drum	D
Campostoma anomalum	Stoneroller	U
Carissius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Cyprinus carpio	Carp	U
Dionda nubila	Ozark minnow	L
Dorosoma cepedianum	Gizzard shad	U
Esox americanus vermiculatus	Redfin pickerel	L
Esox lucius	Northern pike	L
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Eheostoma nigrum	Johnny darter	U
Eucalia inconstans	Brook stickleback	L
Fundulus notatus	Blackstrip topminnow	D
Gambusia affinis	Mosquitofish	D
Hiodon tergius	Mooneye	D
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Hypentalium nigricans	Northern hog sucker	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibossus	Pumpkinseed	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Micropterus doloieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis dorsalis	Bigmouth shiner	L
Notropis heterolepis	Blacknose shiner	L
Notropis lutrensis	Redshiner	D
Notropis rubellus	Rosyface shiner	D

River: Rock River (continued)

Species	Common Name	Status
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Percina caprodes	Logperch	D
Percina phoxocephala		
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D
Umbra limi	Central mudminnow	D

River: Kankakee River

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Aphredoderus sayanus	Priate perch	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzad shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon sucetta	Lake chubsucker	L
Esox americanus americanus	Redfin pickerel	L
Esox americanus vermiculatus	Grass pickerel	D
Esox lucius	Northern pike	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma microperca	Least earter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Organthroat darter	D
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Fundulus notti	Starhead topminnow	L
Hybopsis biguttata	Horneyhead chub	L
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon fossor	Northern brook lamprey	L
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra lamottei	American brook lamprey	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibossus	Pumpkinseed	D
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophys	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D

River: Kankakee River (continued)

Species	Common name	Status
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum breviceps	Southern shorthead redhorse	L
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis amnis	Pallid shiner	L
Notropis blennius	River shiner	D
Notropis chalybaeus	Ironcolor shiner	L
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis emiliae	Pugnose minnow	D
Notropis heterolepis	Blacknose shiner	L
Notropis photogenis	Silver shiner	D
Notropis rebellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis texanus	Weed shiner	I
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Pomosix annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Rhinichthys atratulus	Blacknose dace	D
Salmo gairdneri		
Salmo trutta		
Semotilus atromaculatus	Creek chub	U
Stizostedion vitreum	Walleye	D
Umbra limi	Central mudminnow	D

River: Iroquois River

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Ericymba buccata	Silverjar minnow	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Ictalurus punctatus	Channel catfish	U
Micropterus dolomieui	Smallmouth bass	U
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horneyhead chub	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis lutrensis	Redshiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Percina maculata	Blackside darter	U
Percina phoxodephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Semotilus atromaculatus	Creek chub	U

River: Fox River

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Campostoma oligolepis	Largescale stoneroller	L
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Etheostoma caeruleum	Rainbow darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma zonale	Banded darter	D
Eucalia inconstans	Brook stickleback	L
Fundulus notatus	Blackstripe topminnow	D
Hybognathus hankinsoni	Brassy minnow	I
Ictalurus melas	Black bullhead	U
Ictalurus punctatus	Channel catfish	U
Lampetra lamottei	American brook lamprey	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibossus	Pumpkinseed	D
Morone chrysops	White bass	D
Moxostoma carinatum	River redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis hudsonius	Spottail shiner	L
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnost minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Rhinichthys atratulus	Blacknose dace	D
Salmo gairdneri		
Semotilus atromaculatus	Creek chub	U
Umbra limi	Central mudminnow	D

River: Vermillion River

Species	Common name	Status
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Campostoma anomalum	Stoneroller	U
Carpiodes Carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Cyrinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma exile	Iowa darter	L
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis amblops	Bigeye chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Labidesthes sicculus	Brook silverside	D
Lepomis megalotis	Longear sunfish	U
Lepomis microlophys	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone mississippiensis	Yellow bass	L
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis rebellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D

River: Vermillion River (continued)

Species	Common name	Status
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Noturus stigmosus	Northern madtom	L
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala		
Percina sciera		
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pylodictis olivarus	Flathead catfish	D
Scaphirhynus platorynchus	Shovelnose sturgeon	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D

River: Mackinaw River

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ehteostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma zonale	Banded darter	D
Hypentelium nigricans	Northern hog sucker	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notropis atherinoides	Emerald shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis dorsalis	Bigmouth shiner	L
Notropis lutrensis	Redshiner	D
Notropis rubellus	Rosyface shiner	D
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Noturus flavus	Stonecat	D
Percina maculata	Blackside darter	U
Phenacobius mirobilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U

River: Spoon River

Species	Common name	Status
Campostoma anomalum	Stoneroller	U
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Etheostoma nigrum	Johnny darter	U
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Lepomis cyanellus	Green sunfish	U
Lepomis macrochirus	Bluegill	U
Micropterus dolomieui	Smallmouth bass	U
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis dorsalis	Bigmouth shiner	L
Notropis lutrensis	Redshiner	D
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Percina phoxocephala		
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Semotilus atromaculatus	Creek chub	U

River: Sangamon River

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma aspringene	Mud darter	D
Etheostoma nigrum	Johnny Darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Hiodon alosoides	Goldeye	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis storeriana	Silver chub	D
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophys	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Moxostoma anisurum	Silver redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis dorsalis	Bigmouth shiner	L
Notropis lutrensis	Redshiner	D
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Noturus flavus	Stonecat	D
Noturus nocturnus	Freckled madtom	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnost minnow	U
Pimephales promelas	Fathead minnow	D
Pimphales vigilax	Bullhead minnow	D

River: Sangamon River (continued)

Species	Common name	Status
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U

Salt Creek

Species	Common name	Status
Alpodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Campostoms oligolepis	Largescale stoneroller	L
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Erimyzon sucetta	Lake chubsucker	L
Etheostoma aspringene	Mud darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma zonale	Banded darter	D
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hybognathus argyritis	Western silver minnow	L
Hyboganthus nuchalis	Silvery minnow	D
Hypentelium negricans	Northern hog sucker	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Lampetra lamottei	American brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notropis atherinoides	Emerald shiner	D
Notropis chalybaeus	Ironcolor shiner	L
Notropis lutrensis	Redshiner	D
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Noturus nocturnus	Freckled madtom	D
Percina maculata	Blackside darter	U
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U

Salt Creek

Species	Common name	Status
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D

River: La Moine River

Species	Common name	Status
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersnoi	White sucker	L
Chrosomus erythrogaster	Southern redbelly dace	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Hyboganthus nuchalis	Silvery minnow	D
Hypentelium nigricans	Northern hog sucker	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus cyprinellus	Bigmouth buffalo	D
Lepomis cyanellus	Green sunfish	U
Lepomis macrochirus	Bluegill	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomi biguttatus	Horneyhead chub	D
Notropis atherinoides	Emerald shiner	D
Notropis dorsalis	Bigmouth shiner	L
Notropis lutrensis	Redshiner	D
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Noturus flavus	Stonecat	D
Noturus nocturnus	Freckled madtom	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annularis	White crappie	U
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U

River: Vermillion II

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Cyrpinus carpio	Carp	U
Etheostoma nigrum	Johnny darter	U
Fundulus notatus	Blackstripe topminnow	D
Hyboganthus nuchalis	Silvery minnow	D
Hypentelium nigricans	Northern hog sucker	D
Ictalurus melas	Black bullhead	U
Ictalurus punctatus	Channel catfish	U
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis dorsalis	Bigmouth shiner	L
Notropis lutrensis	Redshiner	D
Notropis rubellus	Rosyface shiner	D
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Noturus falvus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Promoxis annularis	White crappie	U
Semotilus atromaculatus	Creek chub	U

River: Illinois River

Species	Common name	Status
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Campostoma oligolepis	Largescale stoneroller	L
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Chrosomus erythrogaster	Southern redbelly dace	D
Cottus bairdi	Mottled sculpin	D
Cycleptus elongatus	Bluc sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon sucetta	Lake chubsucker	L
Esox americanus vermiculatus	Grass pickerel	D
Esox lucius	Northern pike	L
Etheostoma aspringene	Mud darter	D
Etheostoma caeruleum	Rainbow darter	D
Ehteostoma chlorosomum	Bluntnose darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma gracile	Slough darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma zonale	Banded darter	D
Fundulus notti	Starhead topminnow	L
Gambusia affinis	Mosquitofish	D
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybognathus argyritis	Western silver minnow	L
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis storeriana	Silver chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ictalurus catus	White catfish	L
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepisosteus oculatus	Spotted gar	L
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibbossus	Pumpkinseed	D

River: Illinois River (continued)

Species	Common name	Status
Lepomis gulosis	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophys	Redear sunfish	D
Lepomis punctatus	Spotted sunfish	L
Lota lota lacustris	American burbot	L
Micropterus colomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone mississippiensis	Yellow bass	L
Moxostoma anisurum	Silver redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shine	L
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis dorsalis	Bigmouth shiner	L
Notropis emiliae	Pugnose minnow	D
Notropis hudsonius	Spottail shiner	L
Notropis lutrensis	Redshiner	D
Notropis shumardi	Silverband shiner	L
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus exilis	Slender madtom	L
Noturus gyrinus	Tadpole madtom	D
Noturus nocturnus	Freckled madtom	D
Osmerus mordax	Rainbow smelt	L
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina shumardi	River darter	D
Percopsis omiscomaycus	Trout perch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Polyodon spathula	Paddlefish	D

River: Illinois River (continued)

Species	Common name	Status
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pungitiues pungitius	Ninespine stickleback	I
Pylodictis olivarus	Flathead catfish	D
Phinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D
Umbra limi	Central mudminnow	D

River: Kaskaskia River

Species	Common name	Status
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Ammocrypta clara	Western sand darter	L
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Centrarchus macropterus	Flier	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Ehteostoma aspringene	Mud darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma gracile	Slough darter	D
Ehteostoma nigrum	Johnny darter	U
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hiodon alosoides	Goldeye	D
Hybognathus argyritis	Western silver minnow	L
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis storerianan	Silver chub	D
Hypentielium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus catus	White catfish	L
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepisosteus oculatus	Spotted gar	L
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U

River: Kaskaskia River (continued)

Species	Common name	Status
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone mississippiensis	Yellow bass	L
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis dorsalis	Bigmouth shiner	L
Notropis lutrensis	Redshiner	D
Notropis shumardi	Silverband shiner	L
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Notropis whipplei	Steelcolor shiner	D
Noturus exilis	Slender madtom	L
Noturus flavus	Stonecat	D
Noturus gyrinis	Tadpole madtom	D
Noturus nocturnus	Freckled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina shumardi	River darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Polyodon spathula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Scaphirhynus platorynchus	Shovelnose sturgeon	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Big Muddy River

Species	Common name	Status
Alosa chrysochloris	Skipjack herring	D
Amia calva	Bowfin	D
Aphredoderus sayanus	Pirate perch	D
Catostomus commersoni	White sucker	U
Centrarchus macropterus	Flier	D
Chologaster agassizi	Karst springfish	L
Cyrpinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Elassoma zonatum	Banded pygmy sunfish	L
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma aspringene	Mud darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma gracile	Sluth darter	D
Etheostoma nigrum	Johnny darter	U
Fundulus notatus	Blackstripe topminnow	D
Fundulus notti	Starhead topminnow	L
Fundulus olivaceus	Blackspotted topminnow	L
Gambusia affinis	Mosquitofish	D
Hybognathus nuchalis	Silvery minnow	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepisosteus oculatus	Spotted gar	L
Lepisosteus osseus	Longnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis symmetricus	Bantam sunfish	L
Microp terus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis emiliae	Pugnose minnow	D
Notropis fumeus	Ribbon shiner	L
Notropis lutrensis	Redshiner	D
Notropis shumardi	Silverband shiner	L
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus gyrinus	Tadpole madtom	D
Percina maculata	Blackside darter	U
Percina shumardi	River darter	D

River: Big Muddy River (continued)

Species	Common name	Status
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Polyodon spathula	Paddelfish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D
Umbra limi	Central mudminnow	D

River: Embaras River

Species	Common name	Status
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Esox lucius	Northern pike	L
Etheostoma aspringene	Mud darter	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma gracile	Slough darter	D
Etheostoma histrio	Harlequin darter	L
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hiodon alosoides	Goldeye	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis storeriana	Silver chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra lamottei	American brook lampery	D
Lepisosteus osseus	Longnose gar	D
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largenmouth bass	U
Minytrema melanops	Spotted sucker	D

River: Embaras River (continued)

Species	Common name	Status
Morone mississippiensis	Yellow bass	L
Moxostoma anisurum	Silver redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Notemigonus crysoleucas	Golden shiner	D
Notropis blennius	River shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis fumeus	Ribbon shiner	L
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Phenacobius miravilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D

River: Little Wabash River

Species	Common name	Status
Amia calva	Bowfin	D
Ammocrypta pellucida	Eastern sand darter	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma aspringene	Mud darter	D
Etheostoma blennioides	Greenside darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma gracile	Slough darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis boops	Bigeye shiner	D
Notropis buchanani	Ghost shiner	D
Notropis emiliae	Pugnose minnow	D
Notropis fumeus	Ribbon shiner	L
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D

River: Little Wabash River (continued)

Species	Common name	Status
Notropis whipplei	Steelcolor shiner	D
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Polyodon spathula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis oliverus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D

River: Wabash River

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma aspringene	Mud darter	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma gracile	Slough darter	D
Etheostoma nigrum	Johnny darter	U
Extrarius aestivalis hyostomus	Ohio speckled dace	L
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hiodon alosoides	Goldeye	D
Hiodon terguis	Mooneye	D
Hybognathus argyritis	Western silver minnow	L
Hybognathus nuchalis	Silvery minnow	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis amblops	Bigeye chub	D
Hybopsis biguttata	Horneyhead chub	L
Hybopsis storeriana	Silver chub	D
Hybopsis x-punctata	Gravel chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D

River: Wabash River (continued)

Species	Common name	Status
Lampetra aegyptera	Least brook lamprey	D
Lampetra lamottei	American brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibossus	Pumpkinseed	D
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophys	Redear sunfish	D
Lepomis punctatus	Spotted sunfish	L
Lota lota lacustris	American burbot	L
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma breviceps	Ohio redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum breviceps	Southern shorthead redhorse	L
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northern sand shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis shumardi	Silverband shiner	L
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Osmerus mordax	Rainbow smelt	L

River: Wabash River (continued)

Species	Common name	Status
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Percina shumardi	River darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Polyodon spathula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Salmo gairdneri		
Scaphirhynus platorynchus	Shovelnose sturgeon	L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Umbra limi	Central mudminnow	D

River: Saline River

Species	Common Name	Status
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Centrarchus macropterus	Flier	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma gracile	Slough darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Gambusia affinis	Mosquitofish	D
Hybognathus argyritis	Western silver minnow	L
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Lampetra aegyptera	Least brook lamprey	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis macrochirus	Bluegill	U
Micropterus salmoides	Largemouth bass	U
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis umbratilis	Redfin shiner	D
Notropis whipplei	Steelcolor shiner	D
Noturus gyrinus	Tadpole madtom	D
Percina maculata	Blackside darter	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Promoxis nigromaculatus	Black crappie	D
Semotilus atromaculatus	Creek chub	U

River: Cache River

Species	Common Name	Status
Amia calva	Bowfin	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Centrarchus macropterus	Flier	D
Cottus carolinae	Banded sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gozzard shad	U
Elassoma zonatum	Banded pygmy sunfish	L
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma aspringene	Mud darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma gracile	Slough darter	D
Etheostoma histrio	Harlequin darter	L
Etheostoma kennicotti	Stripetail darter	L
Ehteostoma proeliare	Cypress darter	L
Fundulus olivaceus	Blackspotted topminnow	L
Gambusia affinis	Mosquitofish	D
Hybognathus nuchalis	Silvery minnow	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Lepisosteus oculatus	Spotted gar	L
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Morone chrysops	White bass	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis buchanani	Ghost shiner	D
Notropis fumeus	Ribbon shiner	L
Notropis lutrensis	Redshiner	D
Notropis umbratilis	Redfin shiner	D
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U

River: Cache River (continued)

Species	Common Name	Status
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Umbra limi	Central mudminnow	D

River: Tippecanoe

Species	Common name	Species
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Esox lucius	Northern pike	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma microperca	Least darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma tippecanoe	Tippecanoe darter	D
Fundulus notatus	Blackstripe topminnow	D
Fundulus notti	Starhead topminnow	L
Hybopsis amblops	Bigeye chub	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon fossor	Northern brook lamprey	L
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibbosus	Pumpkinseed	L
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma breviceps	Ohio redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Goldern redhorse	U

Tippecanoe (Cont'd.)

Species	Common name	Status
Moxostoma m. macrolepidotum	Northern shorthead redhorse	D
Nocomis biguttatus	Horneyhead chub	D
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis heterolepis	Blacknose shiner	L
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina sciera	Dusky darter	D
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D
Umbra limi	Central mudminnow	D

River: Eel River

Species	Common Name	Status
Acipenser fulvescens	Lake sturgeon	D
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Aphredoderus sayanus	Pirate perch	D
Campostoma anomalum	Stoneroller	U
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis biguttata	Horneyhead chub	L
Hybopsis micropogon	River chub	L
Ictalurus melas	Black bullhead	U
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibossus	Pumpkinseed	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma rubreques	Greater redhorse	I
Nocomis biguttatus	Horneyhead chub	D
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Noturus exilis	Slender madtom	L

River: Eel River (continued)

Species	Common Name	Status
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	L
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U
Umbra limi	Central mudminnow	D

River: Salamonie River

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Campostoma anomalum	Stoneroller	U
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Organgethroat darter	D
Extrarius aestivalis hyostomus	Ohio speckled dace	L
Fundulus notatus	Blackstripe topminnow	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis cornutus chrysocephalus	Central common shiner	D
Notropis emiliae	Pugnose minnow	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus flavus	Stonecat	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U

River: Mississinewa River

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Labidesthes sicculus	Brook silverside	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma erythrurum	Golden redhorse	U
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Percina maculata	Blackside darter	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Semotilus atromaculatus	Creek chub	U

River: Deer Creek

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma microperca	Least earter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Hybopsis amblops	Bigeye chub	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horneyhead chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface chiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shinner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus miurus	Brindled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Phenacobius mirabilis	Suckermouth minnow	U
Pimpephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U

River: Wildcat Creek

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma microperca	Least earter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis biguttata	Horneyhead chub	L
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Labidesthes sicculus	Brook silverside	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Moxostoma anisurum	Silver redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horneyhead chub	D
Nocomis micropogon	River chub	D
Notropis blennius	River shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U

River: Wildcat Creek (continued)

Species	Common Name	Status
Pomoxis nigromaculatus	Black crappie	D
Semotilus atromaculatus	Creek chub	U

River: Sugar Creek

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma microperca	Least earter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Extrarius aestivalis hyostomus	Ohio speckled dace	L
Fundulus notatus	Blackstripe topminnow	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis storeriana	Silver chub	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Labidesthes sicculus	Brook silverside	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horneyhead chub	D
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Percina caprodes	Logperch	D

River: Sugar Creek (continued)

Species	Common Name	Status
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Pehnacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Promoxis nigromachlatus	Black crappie	D
Semotilus atromaculatus	Creek chub	U

River: Raccoon Creek

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chrosomus erthrogaster	Southern redbelly dace	D
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma exile	Iowa darter	L
Etheostoma microperca	Least earter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis biguttata	Horneyhead chub	L
Hybopsis micropogon	River chub	L
Hybopsis storeriana	Silver chub	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Labidesthes sicculus	Brook silverside	D
Lepomis cyanellus	Green sunfish	U
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horneyhead Chub	
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefin shiner	D
Notropis ariommus	Popeye shiner	L
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D

River: Raccoon Creek (continued)

Species	Common Name	Status
Notropis emiliae	Pugnose minnow	D
Notropis heterolepis	Blacknose shiner	L
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D

River: Fall Creek

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Aphredoderus sayanus	Pirate perch	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Hybopsis amblops	Bigeye chub	D
Labidesthes sicculus	Brook silverside	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horneyhead chub	D
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Percina caprodes	Logperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White Crappie	U

River: Eel River (tributary of the West Fork of the White River)

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Campostoma anomalum	Stoneroller	U
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma microperca	Least earter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis storeriana	Silver chub	D
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma aureolum	Northern redhorse	L
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Percina maculata	Blackside darter	U
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Semotilus atromaculatus	Creek chub	U

River: West Fork of White and White

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma nigrum	Johnny darter	U
Hiodon tergius	Mooneye	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis storeriana	Silver chub	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Labidesthes sicculus	Brook silverside	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibbosus	Pumpkinseed	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma aureolum	Northern redhorse	L
Moxostoma erythrurum	Golden redhorse	U
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefin shiner	D
Notropis ariommus	Popeye shiner	L
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U

West Fork of White and White (Cont'd.)

Species	Common name	Status
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus gyrinus	Tadpole madtom	D
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina evides	Gilt darter	L
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Rhinichthys atratulus	Blacknose dace	D
Scaphrirhynus platorynchus	Shovelnose sturgeon	L
Semotilus atromaculatus	Creek chub	U

River: Sugar Creek (Tributary of the East Fork of the White River)

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus catenatus	Northern studfish	L
Fundulus notatus	Blackstripe topminnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis biguttata	Horneyhead chub	L
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Labidesthes sicculus	Brook silverside	D
Lepomis cyanellus	Green sunfish	U
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth ball	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horneyhead chub	D
Nocomis micropogon	River chub	D
Notropis atherinoides	Emerald shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis photogenis	Silver shiner	D
Notropis rubellus	Roseyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Notropis whipplei	Steelcolor shiner	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U

River: Sugar Creek (Tributary of the East Fork of the White River) (continued)

Species	Common Name	Status
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D

River: Big Blue River (tributary of the East Fork of the White River)

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Cottus bairdi	Mottled sculpin	D
Cyprinus caprio	Carp	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Hybopsis amblops	Bigeye chub	D
Ictalurus natalis	Yellow bullhead	U
Labidesthes sicculus	Brook silverside	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Percina caprodes	Logperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annularis	White crappie	U
Rhinichthys atratulus	Blacknose dace	D
Semotilus atromaculatus	Creek chub	U

River: Flat Rock River

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Ammocrypta pellucida	Eastern sand darter	D
Campostoma anomalum	Stoneroller	U
Catostomus commersoni	White sucker	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma microperca	Least earter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus catenatus	Northern studfish	L
Fundulus notatus	Blackstripe topminnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis dissimilis	Streamline chub	D
Ictalurus natalis	Yellow bullhead	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horneyhead chub	D
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Percina maculata	Blackside darter	U
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Semotilus atromaculatus	Creek chub	U

River: Muscatatuck River

Species	Common Name	Status
Amblopties rupestris	Rock bass	U
Ammocrypta clara	Western sand darter	L
Ammocrypta pellucida	Eastern sand darter	D
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Centrarchus macropterus	Flier	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Fundulus notatus	Blackstripe topminnow	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis storeriana	Silver chub	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Labidesthes sicculus	Brook silverside	D
Lepisosteus osseus	Longnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophys	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis emiliae	Pugnose minnow	D
Notropis photogenis	Silver shiner	D

River: Muscatatuck River (continued)

Species	Common Name	Status
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Percina caprodes	Logperch	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Umbra limi	Central mudminnow	D

River: Patoka River

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Centrarchus macropterus	Flier	D
Cyprinus carpio	Carp	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma chlorosomum	Bluntnose darter	D
Etheostoma gracile	Slough darter	D
Etheostoma nigrum	Johnny darter	U
Fundulus notatus	Blackstripe topminnow	D
Hybognathus nuchalis	Silvery minnow	D
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus cyprinellus	Bigmouth buffalo	D
Lampetra aegyptera	Least brook lamprey	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis megalotis	Longear sunfish	U
Micropterus punctulatus	Spotted bass	D
Minytrema melanops	Spotted sucker	D
Notemigonus crysoleucas	Golden shiner	D
Notropis amnis	Pallid shiner	L
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus miurus	Brindled madtom	D
Percina maculata	Blackside darter	U
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Semotilus atromaculatus	Creek chub	U
Umbra limi	Central mudminnow	D

River: East Fork White

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Ambloplites rupestris	Rock bass	U
Aplodinotus grunniens	Freshwater drum	D
Carpiodes velifer	Highfin carpsucker	D
Catostomus commersoni	White sucker	U
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Esox masquinongy	Muskellunge	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma tippecanoe	Tippecanoe darter	D
Fundulus notatus	Blackstripe topminnow	D
Hiodon tergius	Mooneye	D
Hybognathus nuchalis	Silvery minnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis storeriana	Silver chub	D
Ictalurus punctatus	Channel catfish	U
Labidesthes sicculus	Brook silverside	D
Lepisosteus platostomus	Shortnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Samllmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Moxostoma erythrurum	Golden redhorse	U
Notropis ammis	Pallid shiner	L
Notropis ariommus	Popeye shiner	L
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis emiliae	Pugnose minnow	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Dusky darter	D

East Fork White (Cont'd.)

Species	Common name	Status
Percina shumardi	River darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Semotilus atromaculatus	Creek chub	U

River: Little Pigeon Creek

Species	Common Name	Status
Aphredoderus sayanus	Pirate perch	D
Aplodinotus grunniens	Freshwater drum	D
Centrarchus macropterus	Flier	D
Esox americanus vermiculatus	Grass pickerel	L
Etheostoma nigrum	Johnny darter	U
Fundulus notatus	Blackstripe topminnow	D
Hybognathus hayi	Cypress minnow	L
Hybognathus nuchalis	Silvery minnow	D
Ictalurus natalis	Yellow bullhead	U
Ictalurus punctatus	Channel catfish	U
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis megalotis	Longear sunfish	U
Micropterus punctulatus	Spotted bass	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis amnis	Pallid shiner	L
Notropis atherinoides	Emerald shiner	D
Notropis emiliae	Pugnose minnow	D
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Noturus miurus	Brindled madtom	D
Percina maculata	Blackside darter	U
Percina phoxocephala	Slenderhead darter	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales vigilax	Bullhead minnow	D
Pomoxis annularis	White crappie	U
Semotilus atromaculatus	Creek chub	U

River: Big Blue River

Species	Common Name	Status
Alosa alabamae	Alabama shad	L
Ambloplites rupestris	Rock bass	U
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Cottus bairdi	Mottled sculpin	D
Cottus carolinae	Banded sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Silverjaw minnow	D
Erimyzon oblongus	Creek chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma aspringene	Mud darter	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Fundulus diaphanus	Banded killifish	L
Fundulus notatus	Blackstripe topminnow	D
Hybopsis amblops	Bigeye chub	D
Hybopsis dissimilis	Streamline chub	D
Hybopsis storeriana	Silver chub	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Lepisosteus osseus	Longnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gulosus	Warmouth	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophys	Redear sunfish	D
Menidia audens	Mississippi silverside	L
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Morone mississippiensis	Yellow bass	L
Moxostoma breviceps	Ohio redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D

River: Big Blue River (continued)

Species	Common Name	Status
Notropis albeolus		L
Notropis ardens	Ohio rosefin shiner	D
Notropis ariommus	Popeye shiner	L
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis emiliae	Pugnose minnow	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Percina caprodes	Logperch	D
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Semotilus atromaculatus	Creek chub	U

River: Laughery Creek

Species	Common Name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Ericymba buccata	Silverjaw minnow	D
Etheostoma blennioides	Greenside darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	D
Hybopsis amblops	Bigeye chub	U
Hybopsis storeriana	Silver chub	D
Ictalurus punctatus	Channel catfish	D
Ictiobus bubalus	Smallmouth buffalo	U
Lepomis megalotis	Longear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Moxostoma duquesni	Black redhorse	U
Moxostoma erythrurum	Golden redhorse	D
Notropis boops	Bigeye shiner	U
Notropis cornutus chrysocephalus	Central common shiner	D
Notropis photogenis	Silver shiner	U
Notropis spilopterus	Spotfin shiner	D
Notropis stramineus	Sand shiner	U
Notorpis volucellus	Mimic shiner	D
Notropis whipplei	Steelcolor shiner	U
Phenacobius mirabilis	Suckermouth minnow	D
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Semotilus atromaculatus	Creek chub	U

River: Whitewater

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Carpiodes velifer	Highfin carpsucker	D
Cottus bairdi	Mottled sculpin	D
Cottus carolinae	Banded sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Ericymba buccata	Lake chubsucker	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma spectabile	Orangethroat darter	D
Etheostoma variatum	Varigate darter	D
Etheostoma zonale	Banded darter	D
Hybopsis amblops	Bigeye chub	D
Hybopsis micropogon	River chub	L
Hybopsis storeriana	Silver chub	D
Ictalurus natalis	Yellow bullhead	U
Labidesthes sicculus	Brook silverside	D
Lampetra lamottei	American brook lamprey	D
Lepomis cyanellus	Green sunfish	U
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Moxostoma anisurum	Silver redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Nocomis biguttatus	Horney head chub	D
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefin shiner	D
Notropis ariommus	Popeye shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis boops	Bigeye shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis umbratilis	Redfin shiner	D

Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus eleutherus	Mountain madtom	D
Noturus flavus	Stonecat	D
Noturus miurus	Brindled madtom	D
Noturus nocturnus	Freckled madtom	D
Percina caprodes	Logperch	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	D
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	U
Pomoxis annularis	White crappie	D
Rhinichthys atratulus	Blacknose dace	U
Semotilus atromaculatus	Creek chub	D
		U

River: Guyandotte

Species	Common name	Status
Acipenser fulvescens	Lake sturgeon	D
Alosa chrysochloris	Skipjack herring	D
Alosa pseudoharengus	Alewife	L
Ambloplites rupestris	Rock bass	U
Amia calva	Bowfin	D
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Aplodinotus grunniens	Freshwater drum	D
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Carpiodes velifer	Highfin carpsucker	D
Catastomus catostomus	Longnose gar	L
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Clinostomus elongatus	Redside dace	L
Clinostomus funduloides	Rosyside dace	L
Cottus bairdi	Mottled sculpin	D
Cycleptus elongatus	Blue sucker	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Ericymba buccata	Silverjaw minnow	D
Esox americanus a.	Redfin pickerel	L
Esox americanus vermiculatus	Grass pickerel	D
Esox lucius	Northern pike	L
Esox masquinongy	Muskellunge	L
Esox niger	Chain pickerel	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma tippecanoe	Tippecanoe darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Fundulus diaphanus	Banded killifish	L
Hiodon alosoides	Goldeye	D
Hiodon tergius	Mooneye	D
Hybopsis aestivalis	Speckled chub	D
Hybopsis amblops	Bigeye chub	D
Hybopsis dissimilis	Streamline chub	D
Hybopsis storeriana	Silver chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ichthyomyzon greeleyi	Allegheny brook lamprey	L

Guyandotte (Cont'd.)

Species	Common name	Status
Ichthyomyzon unicuspis	Silver lamprey	D
Ictalurus catus	White catfish	L
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictiobus cyprinellus	Bigmouth buffalo	D
Ictiobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D
Lampetra lamottei	American brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis gibbosus	Pumpkinseed	D
Lepomis gulosus	Warmouth	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Lepomis microlophus	Redear sunfish	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Morone saxatilis	Striped bass	L
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma m. macrolepidotum	Northern shorthead redhorse	D
Nocomis micropogon	River chub	D
Notemigonus crysoleucas	Golden shiner	D
Notropis ardens	Ohio rosefin shiner	D
Notropis ariommus	Popeye shiner	L
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis buchanani	Ghost shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis hudsonius	Spottail shiner	L
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U

Guyandotte (Cont'd.)

Species	Common name	Status
Notropis whipplei	Steelcolor shiner	D
Noturus flavus	Stonecat	D
Noturus gyrinus	Tadpole madtom	D
Noturus insignis	Margined madtom	L
Noturus miurus	Brindled madtom	D
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina macrocephala	Longhead darter	L
Percina maculata	Blackside darter	U
Percina oxyrhyncha		L
Percina phoxocephala	Slenderhead darter	D
Percina sciera	Sharpnose darter	D
Percopsis omiscomaycus	Troutperch	D
Phenacobius mirabilis	Suckermouth minnow	U
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Polyodon spatula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Rhinichthys cataractae	Longnose dace	L
Salmo gairdneri	Rainbow trout	L
Salmo trutta	Brown trout	L
Salvelinus fontinalis	Brook trout	L
Scaphirhynchus platorynchus	Shovelnose sturgeon	L
Semotilus atromaculatus	Creek chub	U
Semotilus margarita	Pearl dace	I
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Kanawha River

Species	Common Name	Status
Alosa chrysochloris	Skipjack herring	D
Alosa pseudoharengus	Alewife	L
Ambloplites rupestris	Rock bass	U
Ammocrypta clara	Western sand darter	L
Ammocrypta pellucida	Eastern sand darter	D
Anguilla rostrata	American eel	D
Campostoma anomalum	Stoneroller	U
Carassius aruatis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Chrosomus oreas		L
Clinostomus funduloides	Rosyside dace	L
Cottus bairdi	Mottled sculpin	D
Cottus carolinae	Banded sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Dorosoma petense	Threadfin shad	L
Ericymba buccata	Silverjaw minnow	D
Esox masquinongy	Muskellunge	L
Esox niger	Chain pickerel	L
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma camurum	Bluebreast darter	D
Etheostoma kanawhae	Kanawha darter	L
Etheostoma maculatum	Spotted darter	L
Etheostoma nigrum	Johnny darter	U
Etheostoma osburni	Finescaled saddled darter	L
Etheostoma tippecanoe	Tippecanoe darter	D
Etheostoma variatum	Variegate darter	D
Etheostoma zonale	Banded darter	D
Exoglossum laurae	Tonguetied minnow	L
Hybopsis aestivalis	Speckled chub	D
Hybopsis amblops	Bigeye chub	D
Hybopsis dissimilis	Streamline chub	D
Hybopsis storeriana	Silver chub	D
Hypentelium nigricans	Northern hog sucker	D
Ichthyomyzon bdellium	Ohio lamprey	D
Ictalurus furcatus	Blue catfish	D
Ictalurus melas	Black bullhead	U
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Ictobus niger	Black buffalo	D
Labidesthes sicculus	Brook silverside	D
Lampetra aegyptera	Least brook lamprey	D
Lepisosteus osseus	Longnose gar	D
Lepmois auritus		L
Lepomis cyanellus	Green sunfish	U

River: Kanawha River (continued)

Species	Common Name	Status
Lepomis gibossus	Pumpkinseed	D
Lepomis gulosus	Warmouth	D
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Minytrema melanops	Spotted sucker	D
Morone chrysops	White bass	D
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma macrolepidotum breviceps	Southern shorthead redhorse	L
Moxostoma macrolepidotum macrolepidotum	Northern shorthead redhorse	D
Moxostoma rhothroecum	Torrent sucker	L I
Nocomis leptocephalus	Bluehead chub	L
Nocomis micropogon	River chub	D
Nocomis platyrhynchus	Bigmouth chub	L
Notemigonus crysoleucas	Golden shiner	D
Notropis albeolus		L
Notropis ardens	Ohio rosefin shiner	D
Notropis ariommus	Popeye shiner	L
Notropis buchanani	Ghost shiner	D
Notropis cerasinus		I
Notropis coccogenis	Warpoint shiner	L
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis galacturus	Whitetail shiner	L
Notropis hudsonius	Spottail shiner	L
Notropis leuciodus	Tennessee shiner	L
Notropis photogenis	Silver shiner	D
Notropis procne	Swallowtail shiner	L
Notropis rubellus	Rosyface shiner	D
Notropis rubricroceus		I
Notropis scabriceps	New River shiner	L
Notropis spilopterus	Spotfin shiner	U
Notropis telescopus	Telescope shiner	L
Notropis umbratilis	Redfin shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Noturus insignis	Margined madtom	L
Noturus miurus	Brindled madtom	D
Peca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina copelandi	Channel darter	D
Percina crassa		L
Percina evides	Gilt darter	L
Percina macrodephala	Longhead darter	

River: Kanawha River (continued)

Species	Common Name	Status
Percina maculata	Blackside darter	U
Percina oxyrhyncha		L
Percina sciera	Dusky darter	D
Percopsis omiscomaycus	Trout perch	D
Phenacobius mirabilis	Suckermouth minnow	U
Phenacobius teretulus	Kanawha minnow	L
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pimephales vigilax	Bullhead minnow	D
Polyodon spathula	Paddlefish	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D
Rhinichthys cataractae	Longnose dace	D
Salmo trutta		L
Salvelinus fontinalis		L
Semotilus atromaculatus	Creek chub	U
Stizostedion canadense	Sauger	D
Stizostedion vitreum	Walleye	D

River: Monongahela

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Carassius auratis	Goldfish	D
Carpiodes carpio	River carpsucker	D
Catostomus commersoni	White sucker	U
Clinostomus elongatus	Redside dace	L
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Fundulus diaphanus	Banded killifish	L
Ictalurus catus	White catfish	L
Ictalurus natalis	Yellow bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Lepisosteus osseus	Longnose gar	D
Lepomis cyanellus	Green sunfish	U
Lepomis c x macrochirus	Hybrid sunfish	I
Lepomis c x gibbosus	Hybrid sunfish	L
Lepomis gibbosus	Pumpkinseed	D
Lepomis humilis	Orangespotted sunfish	D
Lepomis macrochirus	Bluegill	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Micropterus salmoides	Largemouth bass	U
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis atherionoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis deliciosus stramineus	Northeastern sand shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis volucellus	Mimic shiner	U
Notropis whipplei	Steelcolor shiner	D
Percina caprodes	Logperch	D
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D

River: New River

Species	Common Name	Status
Alosa pseudoharengus	Alewife	L
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Catostomus commersoni	White sucker	U
Chrosomus oreas		L
Clinostomus funduloides	Rosyside dace	L
Cottus bairdi	Mottled sculpin	D
Cottus carolinae	Banded sculpin	D
Cyprinus carpio	Carp	U
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma kanawhae	Kanawha darter	L
Etheostoma osburni	Finescaled saddled darter	L
Exoglossum laurae	Tonguetied minnow	L
Exoglossum maxillingua	Cutlips minnow	I
Hybopsis dissimilis	Streamline chub	D
Hypentelium nigricans	Northern hog sucker	D
Ictalurus punctatus	Channel catfish	U
Lepomis auritus		L
Lepomis cyanellus	Green sunfish	U
Lepomis cyanellus x gibossus	Hybrid sunfish	L
Lepomis gibossus	Pumpkinseed	D
Micropterus dolomieui	Smallmouth bass	U
Micropterus punctulatus	Spotted bass	D
Morone chrysops	White bass	D
Nocomis leptocephalus	Bluehead chub	L
Nocomis platyrhynchus	Bigmoutn chub	L
Notropis albeolus		L
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis galacturus	Whitetail shiner	L
Notropis hudsonius	Spottail shiner	L
Notropis photogenis	Silver shiner	D
Notropis procne	Swallowtail shiner	L
Notropis scabriceps	New River shiner	L
Notropis spilopterus	Spotfin shiner	U
Notropis telescopus	Telescope shiner	L
Notropis volucellus	Mimic shiner	U
Noturus insignis	Margined madtom	L
Perca flavescens	Yellow perch	D
Percina crassa		L
Percina maculata	Blackside darter	U
Percina oxyrhyncha		L
Phenacobius teretulus	Kanawha minnow	L
Pimephales notatus	Bluntnose minnow	U
Pimephales promelas	Fathead minnow	D
Pomoxis annularis	White crappie	U
Pomoxis nigromaculatus	Black crappie	D
Pylodictis olivarus	Flathead catfish	D
Rhinichthys atratulus	Blacknose dace	D

River: New River (continued)

Species	Common Name	Status
Rhinichthys cataractae	Longnose dace	D
Semotilus atromaculatus	Creek chub	U

River: Allegheny

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Carassius auratis	Goldfish	D
Carpiodes cyprinus	Quillback	U
Catostomus commersoni	White sucker	U
Cottus bairdi	Mottled sculpin	D
Cyprinus carpio	Carp	U
Dorosoma cepedianum	Gizzard shad	U
Exos lucius	Northern pike	L
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Etheostoma zonale	Banded darter	D
Fundulus diaphanus	Banded killifish	L
Hybopsis dissimilis	Streamline chub	D
Hypentelium nigricans	Northern hog sucker	D
Ictalurus nebulosus	Brown bullhead	D
Ictalurus punctatus	Channel catfish	U
Ictiobus bubalus	Smallmouth buffalo	D
Lepomis gibbosus	Pumpkinseed	L
Lepomis macrochirus	Bluegill	U
Micropterus dolomieui	Smallmouth bass	U
Micropterus salmoides	Largemouth bass	U
Moxostoma anisurum	Silver redhorse	D
Moxostoma carinatum	River redhorse	D
Moxostoma duquesni	Black redhorse	D
Moxostoma erythrurum	Golden redhorse	U
Moxostoma m. macrolepidotum	Northern shorthead redhorse	D
Notemigonus crysoleucas	Golden shiner	D
Notropis atherinoides	Emerald shiner	D
Notropis blennius	River shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis photogenis	Silver shiner	D
Notropis rubellus	Rosyface shiner	D
Notropis spilopterus	Spotfin shiner	U
Notropis stramineus	Sand shiner	D
Notropis volucellus	Mimic shiner	U
Perca flavescens	Yellow perch	D
Percina caprodes	Logperch	D
Percina oxyrhyncha		L
Percopsis omiscomaycus	Troutperch	D
Pomoxis annularis	White crappie	U
Pylodictis olivarus	Flathead catfish	D
Semotilus atromaculatus	Creek chub	U
Stizostedion vitreum	Walleye	D

River: Pymatunig (major tributary of the Beaver River)

Species	Common name	Status
Ambloplites rupestris	Rock bass	U
Campostoma anomalum	Stoneroller	U
Catostomus commersoni	White sucker	U
Chrosomus erythrogaster	Southern redbelly dace	D
Clinostomus elongatus	Redside dace	D
Ericymba buccata	Silverjaw minnow	D
Esox americanus vermiculatus	Grass pickerel	D
Etheostoma blennioides	Greenside darter	D
Etheostoma caeruleum	Rainbow darter	D
Etheostoma flabellare	Fantail darter	D
Etheostoma nigrum	Johnny darter	U
Eucalia inconstans	Brook stickleback	L
Hypentelium nigricans	Northern hog sucker	D
Ictalurus melas	Black bullhead	U
Ictalurus nebulosus	Brown bullhead	D
Lepomis cyanellus	Green sunfish	U
Lepomis macrochirus	Bluegill	U
Lepomis megalotis	Longear sunfish	U
Moxostoma erythrurum	Golden redhorse	U
Notemigonus crysoleucas	Golden shiner	D
Notropis cornutus chrysocephalus	Central common shiner	U
Notropis umbratilis	Redfin shiner	D
Noturus gyrinus	Tadpole madtom	D
Percina maculata	Blackside darter	U
Pimephales notatus	Bluntnose minnow	U
Pomoxis annularis	White crappie	U
Semotilus atromaculatus	Creek chub	U
Umbra limi	Central mudminnow	D

References for Appendix C

(1) Clay, W. M.. 1975. The Fishes of Kentucky. Kentucky Department of Fish and Wildlife Resources, Frankfort, Kentucky.

(2) Rankin, Dennis. n.d. Aquatic Ecology. Unpublished report of aquatic resources in the rivers of West Virginia.

(3) Miles, R. n.d. Checklist of West Virginia Fishes. Unpublished report.

(4) Gerking, Shelby. 1945. Distribution of the Fishes of Indiana. Indiana Department of Conservation. Division of Fish and Game. Department of Zoology, Indiana University, Indianapolis, Indiana.

(5) Huffaker, Steve. 1973. Unpublished report of stream survey of Sugar Creek, Indiana. Indiana Department of Natural Resources, Division of Fish and Wildlife.

(6) Janisch, Joseph L. 1972. Unpublished report of stream survey of Blue River, Indiana. Indiana Department of Natural Resources, Division of Fish and Wildlife.

(7) Robertson, Robert. 1975. Unpublished report of stream survey of the Middle Wabash River, Indiana. Indiana Department of Natural Resources, Division of Fish and Wildlife.

(8) Pearson, Jed. 1975. Unpublished report of stream survey of the Upper Wabash River, Indiana. Indiana Department of Natural Resources, Division of Fish and Wildlife.

(9) Taylor, Melvin. 1972. Unpublished report of stream survey of Eel River, Indiana. Indiana Department of Natural Resources. Division of Fish and Wildlife.

(10) Pearson, Jed. 1976. Unpublished report of stream survey of Upper Stretches of the White River, West Fork.

(11) Robertson, Robert. 1972. Unpublished report of stream survey of Kanhakee River, Indiana. Indiana Department of Natural Resources, Division of Fish and Wildlife.

(12) Huffaker, Steve. 1971. Unpublished report of stream survey of the Upper West Fork of the Whitewater River. Indiana Department of Natural Resources, Division of Fish and Wildlife.

(13) Robertson, Robert. 1974. Unpublished report of stream survey of the Tippecanoe River, Indiana. Indiana Department of Natural Resources, Division of Fish and Wildlife.

(14) McReynolds, H. E. (Study Leader) 1960. Muscatatuck River Studies, Final Report. Indiana Department of Conservation, Division of Fish and Game.

(15) Huffaker, Steven. 1972. Unpublished report of stream survey of Big Raccoon Creek, Indiana. Indiana Department of Natural Resources, Division of Fish and Wildlife.

(16) Robertson, Robert. 1974. Unpublished report of stream survey of Wildcat Creek, Indiana. Indiana Department of Natural Resources Division of Fish and Wildlife.

(17) Trautman, M. D. 1957. Fishes of Ohio. The Ohio State University Press.

(18) ORSANCO. Unpublished reports of lock and dam studies.

(19) Sparks, Richard E. and Starrett, W. C. 1974. An Electrofishing Survey of the Illinois River 1959-1974.

(20) Smith, Philip. 1979. The Fishes of Illinois. University of Illinois Press, Urbana, Illinois.

(21) Kay, G. P., Syokora, J. L., Shapiro, M. A. 1979. ORBES Baseline Data Document for Pennsylvania.

(22) Hoyt, R. D., Neff, S. E., and Resh, V. H. 1979. Distribution, Abundance, and Species Diversity of Fishes of the Upper Salt River Drainage, Kentucky. Trans. Ky. Acad. Sci. Vol. 40 (1,2): 1-20.

(23) Bauer, B. and Branson, B. 1979. Distributional Records for and Additions to the Ichthyo Fauna of Kentucky. Trans. Ky. Acad. Sci. Vol. 40 (1 and 2): 53-55.

(24) Burr, B. M. and Mayden, R. L. 1979. Records of Fishes in Western Kentucky with Additions to the Known Fauna. Trans. Ky. Acad. Sci. Vol. 40 (1 and 2): 58-67.

(25) Ohio River Valley Water Sanitation Commission. 1962. Aquatic-Life Resources of the Ohio River. ORSANCO. Cincinnati, Ohio.

APPENDIX D

The information presented in this appendix is a presentation of available information from the literature concerning habitats of the various ORBES fishes. The fish species are listed along the left and numberical codes for various habitat requirements across the top of the page. An explanation of the coding system is given on the first page of the table. The "X" citation for a habitat characteristic and particular species of fish signifies only that documentation exists for the occurrence of the species in that particular habitat type. Thus, the "X" citation does not signify that this is the only place the fish may be found. Information was not found documenting the habitat of many of the fish species in this region.

The three references used in assimilating the information for Appendix D were Smith (1), Clay (2), and Trautman (3). These three authors are noted ichthyologists and have discussed the habitat restrictions and needs of the fishes which occur in the streams of their states, respectively, Kentucky, Illinois, and Ohio. Information used in this report to document the occurrence of fish species as recorded in Appendix C in the other ORBES states (Indiana, West Virginia, and Pennsylvania) did not include habitat characteristics. Thus any "X" citation denoting a habitat characteristic of a species of fish in Appendix D is as documented by one or all three of the above references. It is assumed that the habitat requirements of a fish species is the same throughout the ORBES region.

Appendix D: Habitat Requirements of Fishes of the ORBES Region

Habitat Codes

- A Stream Reach
  - 1 Headwater
  - 2 Mouth
- B Gradient
  - 1 High gradient
  - 2 Moderate gradient
  - 3 Low gradient
- C Flow
  - 1 Swift
  - 2 Flowing
  - 3 Sluggish
  - 4 Stagnant
- D Setting
  - 1 Riffles
  - 2 Pools
  - 3 Impoundments
- E Vegetation and Debris
  - 1 With debris and/or vegetation
  - 2 Without debris and/or vegetation
- F Size
  - 1 Streams
  - 2 Rivers
- G Depth
  - 1 Shallow
  - 2 Deep
- H Stream Bed
  - 1 Soft
  - 2 Firm
- I Bottom Characteristics
  - 1 Silt
  - 2 Sand
  - 3 Gravel
  - 4 Rubble
  - 5 Mixture
  - 6 Mud
  - 7 Stone
- J Other
  - 1 Migratory
  - 2 Underground

SPECIES	HABITAT CODE																												
	A.		B			C.				D.			E		F		G		H		I							J.	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Acipenser fulvescens		X												X		X						X	X	X				X	
Alosa alabamae																X												X	
Alosa chrysochloris		X				X										X					X	X	X					X	
Alosa pseudoharengus		X							X																				
Ambloplites reupestris	X	X		X							X		X			X				X			X	X			X		
Amblyopsis spelaea											X											X	X	X	X	X			X
Amia calva		X			X			X			X		X			X	X												
Ammocrypta pellucida	X						X				X				X	X		X	X			X							
Ammocrypta clara	X															X						X							
Anguilla rostrata		X									X		X		X			X				X	X			X		X	
Aphredoderus sayanus		X			X			X			X		X	X	X			X								X			
Aplodinotus grunniens		X			X			X			X					X	X	X											
Campostoma anomalum		X	X	X			X			X	X				X	X				X		X	X		X		X	X	
Campostoma oligolepis										X					X							X	X				X		
Carassius auratis	X	X		X	X			X			X		X		X	X	X												
Carpiodes carpio		X									X		X		X	X		X			X	X	X						
Carpiodes cyprinus	X	X			X						X		X		X	X				X	X	X	X			X	X		

SPECIES	HABITAT CODE A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Carpiodes velifer	X	X			X					X				X	X	X		X			X	X	X		X			X	
Catastomus catostomus																													
Catostomus commersoni	X	X	X	X	X	X				X	X	X	X	X	X	X		X				X	X	X					X
Centrarchus macropterus					X			X	X						X											X			
Chologaster agassizi	X																												X
Chrosomus erythrogaster	X					X					X			X	X		X			X			X						
Chrosomus oreas																													
Clinostomus elongatus	X		X	X		X					X				X					X		X	X	X					
Clinostomus funduloides						X					X				X														
Clinostomus vandoisulus	X												X							X			X	X					
Cottus bairdi	X	X	X		X						X		X	X	X					X		X	X	X					
Cottus carolinae	X		X				X			X	X													X					
Ctenopharyngodon idella													X			X													
Cycleptus elongatus		X				X				X					X	X		X					X					X	
Cyprinus carpio	X	X		X	X			X	X		X		X			X			X										
Dionda nubila						X									X								X						
Dorosoma cepedianum	X	X			X	X		X	X		X	X	X		X	X	X	X			X					X		X	

SPECIES	HABITAT CODE A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Dorosoma petense		X									X		X			X			X			X							
Elassoma zonatum								X									X												
Ericymba buccata	X	X		X	X		X			X	X				X	X						X	X						
Erimyzon oblongus	X			X	X				X		X		X		X				X	X		X	X					X	
Erimyzon sucetta	X				X								X		X							X	X						
Esox a. americanus																													
Esox american vermiculatus	X				X			X			X		X		X		X		X		X					X			
Esox lucius	X										X		X		X	X													
Esox masquinongy	X	X			X						X		X									X							
Esox niger													X																
Etheostoma asprigene								X	X																	X			
Etheostoma atripinne										X					X														
Etheostoma bellum																													
Etheostoma blennioides	X	X	X	X		X				X	X				X	X	X							X					
Etheostoma caeruleum	X		X	X	X			X		X					X		X					X	X	X			X		
Etheostoma camurum						X				X					X		X					X	X	X				X	
Etheostoma chlorosomum								X	X					X	X				X		X	X				X			

SPECIES	HABITAT CODE A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Etheostoma cinereum																													
Etheostoma exile													X									X							
Etheostoma flabellare	X						X	X		X	X				X		X					X	X	X				X	
Etheostoma gracile						X		X		X	X								X	X	X	X				X			
Etheostoma histrio											X					X		X		X									
Etheostoma kanawhae																													
Etheostoma kennicotti			X							X					X	X	X			X		X	X						
Etheostoma maculatum	X					X				X													X	X					
Etheostoma microlepidum										X					X		X						X	X					
Etheostoma microperca	X				X			X			X		X						X		X	X							
Etheostoma neopterum																													
Etheostoma nigrum	X	X		X				X			X				X		X			X		X	X	X					
Etheostoma obeyense			X			X				X	X												X	X					
Etheostoma osburni																													
Etheostoma parvipinne	X													X	X							X	X						
Etheostoma proeliare								X				X	X		X														
Etheostoma rufilineatum																													

SPECIES	HABITAT CODE A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Etheostoma sagitta	X																												
Etheostoma spectabile	X	X		X	X		X	X		X			X	X	X		X				X	X	X						
Etheostoma squamiceps							X			X					X	X						X	X						
Etheostoma stigmaeum						X	X										X			X		X	X	X					
Etheostoma swaini										X			X		X							X	X						
Etheostoma tippecanoe						X	X	X		X					X		X					X	X	X					
Etheostoma variatum			X			X				X					X	X						X	X	X				X	
Etheostoma virgatum																													
Etheostoma zonale	X		X	X		X		X		X			X		X	X	X			X		X	X	X			X		
Eucalia inconstans	X												X																
Fundulus catenatus	X					X				X				X	X							X	X						
Fundulus diaphanus		X															X					X	X	X					
Fundulus notatus			X		X	X							X		X	X													
Fundulus notti					X								X																
Fundulus olivaceus					X																								
Gambusia affinis					X			X	X		X	X	X		X	X	X												
Hiodon a alosoides	X	X			X	X	X				X				X	X		X		X		X							

SPECIES	HABITAT CODE																												
	A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Hiodon tergius		X			X	X		X							X	X		X		X									
Hybognathus argyritis													X			X					X	X							
Hybognathus hankinsoni											X		X		X												X		
Hybognathus hayi								X	X					X	X						X			X			X		
Hybognathus nuchalis							X	X			X				X	X			X	X	X	X							
Hybognathus placitus	X														X		X				X								
Hybopsis a aestivalis		X				X				X						X	X	X		X		X	X						
Hybopsis amblops	X	X	X			X							X	X	X	X				X		X	X						
Hybopsis biguttata	X							X					X		X							X	X						
Hybopsis dissimilis	X									X				X	X		X			X		X	X						
Hybopsis gelida						X				X						X	X						X						
Hybopsis gracilis							X									X			X			X							
Hybopsis insignis																													
Hybopsis meeki						X										X				X		X	X						
Hybopsis micropogon	X													X	X					X			X	X					
Hybopsis storeriana		X			X		X				X			X		X		X			X	X	X		X	X			
Hybopsis x-punctata	X	X		X		X	X			X				X	X		X	X		X		X	X						

SPECIES	HABITAT CODE A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Hypentelium nigricans	X	X	X	X	X	X	X			X		X		X	X			X		X		X	X	X				X	X
Ichthyomyzon bdellium		X								X					X	X	X				X		X					X	
Ichthyomyzon castaneus										X						X	X				X								
Ichthyomyzon fossor	X		X		X					X			X		X							X	X					X	
Ichthyomyzon greeleyi	X		X	X	X					X			X		X							X	X					X	
Ichthyomyzon unicuspis		X		X											X	X			X		X	X	X					X	
Ictalurus catus		X														X													
Ictalurus furcatus		X			X	X									X	X		X				X	X	X			X		
Ictalurus melas	X	X			X			X				X			X	X	X		X		X					X			
Ictalurus natalis		X			X			X					X		X		X	[illegible]			X	X	X						
Ictalurus nebulosus	X	X										X	X		X	X		X											
Ictalurus punctatus	X	X			X	X		X		X				X	X	X		X			X	X	X	X				X	
Ictiobus bubalus	X	X				X	X		X		X				X	X		X		X	X					X			
Ictiobus cyprinellus		X			X			X			X				X	X	X												
Ictiobus niger		X			X										X	X	X									X			
Labidesthes sicculus		X				X	X						X	X	X					X	X	X	X	X	X	X			
Lampetra aegyptera	X		X			X		X		X			X		X		X					X	X						

SPECIES	HABITAT CODE																												
	A		B			C				D			E		F		G		H		I							J.	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Lampetra lamottei						X				X					X	X							X					X	
Lepisosteus oculatus					X			X	X		X		X		X								X						
Lepisosteus osseus		X			X		X				X		X	X	X	X												X	
Lepisosteus platostomus		X			X						X			X		X						X	X				X		
Lepisosteus spatula		X			X											X													
Lepomis auritus																													
Lepomis cyanellus		X							X			X	X		X	X													
Lepomis c x macrochirus																													
Lepomis c x gibossus																													
Lepomis gibbosus		X							X				X									X				X			
Lepomis gulosis																													
Lepomis humilis	X	X			X			X				X			X	X					X								
Lepomis macrochirus		X						X	X		X	X	X			X	X					X	X						
Lepomis marginatus								X	X		X		X																
Lepomis megalotis	X	X	X	X	X			X			X	X	X		X		X		X	X		X	X						
Lepomis microlophus		X							X				X																
Lepomis punctatus													X								X	X				X			

SPECIES	HABITAT CODE																												
	A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Lepomis symmetricus					X			X	X																				
Lota lota lacustris																													
Menidia audens																													
Micropterus coosae																													
Micropterus dolomieui	X	X	X	X	X		X	X		X	X				X			X		X			X	X			X	X	
Micropterus punctulatus	X	X		X	X		X	X			X	X			X		X				X		X					X	
Micropterus salmoides	X	X		X	X			X				X	X		X				X	X	X	X	X			X			
Minytrema melanops	X	X		X	X						X		X	X	X	X			X	X		X	X						
Morone chrysops		X					X	X				X	X	X	X		X	X	X	X	X								
Morone mississippiensis		X						X	X			X			X														
Morone saxatilis		X																											
Moxostoma anisurum	X	X			X	X	X			X	X			X	X	X		X		X		X	X	X	X				X
Moxostoma atripinne							X				X				X					X									
Moxostoma aureolum																													
Moxostoma breviceps		X				X	X				X				X							X	X						
Moxostoma carinatum	X	X				X				X						X		X					X						
Moxostoma duquesni	X	X	X	X		X	X							X	X	X				X		X	X	X					

SPECIES	HABITAT CODE																												
	A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Moxostoma erythrurum	X	X		X						X	X			X	X	X				X		X	X	X				X	
Moxostoma m. breviceps																													
Moxostoma m.macrolepidotum	X	X	X			X					X					X				X		X	X						
Moxostoma rhothroecum																													
Moxostoma rubreques																													
Nocomis biguttatus	X		X										X	X	X	X				X			X				X		
Nocomis effusus				X	X										X								X	X					
Nocomis leptocephalus																													
Nocomis micropogon	X		X												X					X									
Nocomis platyrhynchus																													
Notemigonus crysoleucas	X	X			X			X	X		X		X		X	X			X			X				X			
Notropis albeolus																													
Notropis amnis		X						X	X		X		X																
Notropis ardens	X	X	X	X		X				X	X			X	X			X		X		X	X						
Notropis ariommus						X					X												X	X					
Notropis atherinoides	X	X				X	X								X	X				X	X	X	X	X	X	X	X		
Notropis blennius		X				X	X							X	X	X		X			X	X	X						

SPECIES	HABITAT CODE																													
	A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Notropis boops	X	X	X	X			X						X	X					X	X		X	X		X		X		
Notropis buchanani		X					X						X			X			X		X	X	X						
Notropis cerasinus																													
Notropis chalybaeus													X		X				X			X							
Notropis coccogenis	X					X																X	X						
Notropis cornutus chrysocephalus	X	X	X	X	X	X	X			X	X		X		X		X			X		X	X	X	X			X	
Notropis deliciosus stramineus	X	X	X		X	X	X								X					X		X	X						
Notropis dorsalis															X	X	X					X							
Notropis emiliae		X			X			X	X		X		X	X	X	X			X			X				X			
Notropis fumeus				X	X			X					X							X		X				X			
Notropis glalcturus																													
Notropis heterolepis	X				X			X			X		X		X							X	X			X			
Notropis hudsonius																X													
Notropis leuciodus	X		X												X														
Notropis lutrensis							X	X			X		X		X	X					X	X	X		X				
Notropis maculatus		X			X			X	X																				
Notropis photogenis	X		X	X		X	X			X	X			X	X	X				X			X	X			X		

SPECIES	HABITAT CODE																												
	A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Notropis procne																													
Notropis rubellus	X	X	X			X				X	X				X	X				X		X	X	X					
Notropis rubricroceus																													
Notropis scabriceps																													
Notropis shumardi							X									X						X	X						
Notropis spilopterus	X	X			X		X	X		X			X		X	X	X	X		X	X	X	X		X	X			
Notropis stramineus		X		X	X	X									X	X						X	X		X				
Notropis telescopus																													
Notropis texanus													X		X							X							
Notropis umbratilis	X			X	X	X		X		X	X		X	X	X	X					X	X	X						
Notropis venustus						X								X	X							X							
Notropis volucellus	X	X	X		X		X	X		X	X		X		X	X					X	X	X						
Notropis whipplei	X	X		X		X			X	X	X		X		X	X					X		X	X					
Noturus elegans																													
Noturus eleutherus	X	X				X				X			X		X	X	X	X		X		X	X	X					
Noturus exilis						X				X					X								X						
Noturus flavus		X		X		X				X			X		X	X				X			X	X			X		

SPECIES	HABITAT CODE																												
	A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Noturus furiosus		X				X				X						X	X	X				X	X	X					
Noturus gyrinus			X		X			X		X	X		X		X				X	X	X	X	X						
Noturus hildebrandi										X			X				X					X	X						
Noturus insignis																													
Noturus miurus	X		X	X	X	X		X	X	X	X		X		X	X	X		X	X	X	X	X	X					
Noturus nocturnus								X		X					X	X		X		X	X	X	X						
Noturus phaeus										X			X						X		X	X	X						
Noturus stigmosus							X								X	X						X	X						
Noturus trautmani																													
Osmerus mordax																													
Parexoglossum laurae hubbsi	X			X						X	X											X	X						
Perca flavescens		X			X								X									X	X						
Percina caprodes	X	X								X	X				X	X	X	X				X	X						
Percina copelandi		X				X	X	X								X	X	X				X	X						
Percina crassa																													
Percina cymatotaenia																						X		X					
Percina evides																													

SPECIES	HABITAT CODE																												
	A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Percina macrocephala			X			X				X	X				X			X				X	X	X					
Percina maculata	X	X		X			X	X		X	X				X	X						X	X					X	
Percina oxyrhyncha																													
Percina phoxocephala	X	X				X	X			X	X		X			X	X			X		X	X	X					
Percina sciera				X	X	X				X			X		X		X						X					X	
Percina shumardi		X				X	X	X		X					X	X	X	X		X		X	X	X					
Percina squamata																													
Percina uranidea					X		X										X					X							
Percopsis omiscomaycus	X	X			X						X		X		X			X				X	X						
Phenacobius mirabilis	X	X	X	X		X		X		X					X	X						X	X						
Phenacobius teretulus																													
Phenacobius uranops							X				X									X		X		X					
Pimephales notatus	X	X	X	X	X			X	X	X	X		X		X	X	X		X	X	X	X	X	X	X	X	X	X	
Pimephales promelas	X	X			X		X	X			X		X		X	X					X	X				X			
Pimephales vigilax		X						X	X					X	X	X					X	X	X		X	X			
Polyodon spathula		X			X	X		X			X					X							X					X	
Pomoxis annularis		X			X			X			X	X	X		X	X		X	X	X						X			

SPECIES	HABITAT CODE																												
	A		B			C				D			E		F		G		H		I							J	
	1	2	1	2	3	1	2	3	4	1	2	3	1	2	1	2	1	2	1	2	1	2	3	4	5	6	7	1	2
Pomoxis nigromaculatus		X			X		X		X			X	X		X	X						X				X			
Pungitius pungitius																													
Pylodictis olivarus		X			X			X		X	X		X		X	X	X	X		X						X			
Rhinichthys atratulus	X		X	X		X				X	X		X		X		X			X		X	X		X				
Rhinichthys cataractae										X							X						X						
Salmo gairdneri						X									X														
Salmo trutta											X		X		X			X											
Salvelinus fontinalis	X					X	X			X			X		X	X							X						
Scaphirhynchus alba																X													
Scaphirhynus platorynchus		X								X				X	X	X						X	X					X	
Semotilus atromaculatus	X	X	X		X					X	X		X	X	X				X	X	X	X	X	X	X	X	X		
Semotilus corporalis																													
Semotilus margarita																													
Stizostedion canadense	X	X			X							X				X	X	X		X								X	
Stizostedion vitreum		X											X		X		X			X		X	X	X			X	X	
Typhlichthys subterraneus																													X
Umbra limi	X										X		X		X		X		X							X			

APPENDIX E

Explanation notes for Tables E-1 to E-30

[1] Tables 1-3 list the reference standards used in the ORBES study to compare increments in ambient concentrations of constituents. These standards are based on current legal statutes but may not be exactly the same as state standards for a given river. Designations in the table are as follows: Blank - if overall stream reaches the maximum incremental concentration due to loading and consumption is $< 10\%$ of the reference standard in Tables 1-3; 10 - if this incremental concentration is $\geq 10\%$ of the standard but $< 25\%$; 25 - if this incremental concentration is $\geq 25\%$ of the standard but $< 50\%$ and; 50 - if this incremental concentration is $\geq 50\%$ of the standard.

[2] Water consumption impacts are designated as light (L) if the portion of 7-day, 10-year low flow consumed is $< 10\%$; moderate (M) if this portion is $\geq 10\%$ but $< 25\%$ and; heavy (H) if $> 25\%$.

[3] Figure 1-2 map numbers.

TABLE E-1

Water Quality[1] and Consumption Impacts[2] -- 0% Loading Assignment Scenario 1 :

Parameters	mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption		M	M	M	L	L	M	M	M	M	M	L	L	M	M	L	M	L	M	M	M	M	M	M	M
TDS	500								10										25		50				
TSS	50						10		50						10		10	10	50		10				10
SO_4	250								10																
NH_3	1.1																		10						
As	0.05																				50				
Ba	1.0																								10
Cd	0.01								10										50						
Cl	250																				50				
Cr	0.01								50						25	10		10	50		50	25			50
P	0.05	50					50	50	50						50	10	10	50	50		10	50		25	50
Se	0.01								25										25			10			
Ag	0.005								10						25	10									25
Cu	0.06	10							50										50		25				25
Fe	0.3	50					25	25	50				10		50	50		50	50		50	50		25	50
Pb	0.05	10							25						10	25		10	50		50	10		25	50
Mn	0.05	25					10		50				25		50	50		25	50		50	50		25	50
Hg (µg/1)	0.05	50				50	25	50	50						50	50		50	50		50	50		50	50
Ni	0.05																								
Zn	0.205								25										10		10	25			
B	1.00																								

TABLE E-2

Water Quality[1] and Consumption Impacts[2] -- 0 % Loading Assignment Scenario 2 : (3)

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS 500																				10				
TSS 50														10	10									10
SO_4 250																								
NH_3 1.1																			10					
As 0.05																				10				
Ba 1.0																								
Cd 0.01																								25
Cl 250																				25				
Cr 0.01														25	25		10		25	25	25			50
P 0.05	50					25	50							50	25		25		50	10	25		10	50
Se 0.01																			10		10			
Ag 0.005														25	25				50					25
Cu 0.06	10																		25	10				25
Fe 0.3	50					10	25					10		50	50		50		50	50	50		25	50
Pb 0.05	10													10	50				10	10	10		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg 0.05 (µg/1)	50				50	10	50							50	50		25		50	50	50		25	50
Ni 0.05																								
Zn 0.205																			10		25			10
B 1.00																								

TABLE E-3

Water Quality[1] and Consumption Impacts[2] -- 0 % Loading Assignment Scenario 2a:

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	M	M	M	M	M	M	M
TDS 500																			10	10				
TSS 50														10	10					10				10
SO_4 250																								
NH_3 1.1																			10					
As 0.05																				10				
Ba 1.0																								
Cd 0.01															10				10					25
Cl 250																								
Cr 0.01														50	25		10		50	50	25			50
P 0.05	50					25	50							50	25		25		50	25	25		10	50
Se 0.01														10					10	10	10			
Ag 0.005														25	25				50					50
Cu 0.06	10																		25	10				50
Fe 0.3	50					10	25					10		50	50		50		50	50	50		25	50
Pb 0.05	10													10	50				10	10	10		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg (µg/l) 0.05	50				50	10	25							50	50		25		50	50	50		25	50
Ni 0.05																								
Zn 0.205																			10	10	25			10
B 1.00																								

TABLE E-4

Water Quality[1] and Consumption Impacts[2] -- 0 % Loading Assignment Scenario 2b :

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS 500																				10	10			
TSS 50														10	10					10	10			10
SO_4 250																					10			
NH_3 1.1																					10			
As 0.05																			10	10				
Ba 1.0																								25
Cd 0.01																					10			
Cl 250																								
Cr 0.01														25	25		10		25	50	50			50
P 0.05	50					25	50							50	25		25		50	25	50		10	50
Se 0.01																			10	10	25			10
Ag 0.005														25	25				50					50
Cu 0.06	10																		25	10	10			50
Fe 0.3	50					10	25					10		50	50		50		50	50	50		25	50
Pb 0.05	10													10	50				10	25	25		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg 0.05 (µg/1)	50				50	10	50							50	50		25		50	50	50		25	50
Ni 0.05																								
Zn 0.205																				10	50			10
B 1.00																								

TABLE E-5

Water Quality[1] and Consumption Impacts[2] -- 0 % Loading Assignment Scenario 2c :

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS 500							10													10				10
TSS 50							10	10																
SO_4 250																								
NH_3 1.1																								
As 0.05																								
Ba 1.0																								
Cd 0.01																								10
Cl 250																								
Cr 0.01								10						10	10					25				50
P 0.05	50				10	25	50	10						50	10		25	25		10	50			50
Se 0.01														10										
Ag 0.005														25			10							25
Cu 0.06	25				10																			25
Fe 0.3	50				10	10	25	50						25	50		10	50		50	50		10	50
Pb 0.05	25														25			10		10				50
Mn 0.05	50							50						25	50			25		50	50			50
Hg 0.05 (µg/1)	50				50	10	50	25						50	50		50	25		50			10	50
Ni 0.05																								
Zn 0.205																					10			10
B 1.00																								

TABLE E-6

Water Quality[1] and Consumption Impacts[2] -- 0 % Loading Assignment Scenario 3 :

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	L	M	M
TDS 500																				10				10
TSS 50																								
SO_4 250																								
NH_3 1.1																								
As 0.05																				10				
Ba 1.0																								
Cd 0.01																								10
Cl 250																								
Cr 0.01														10	25		10		10	25	25			50
P 0.05	50					25	50							25	25		25		10	25	25		10	50
Se 0.01																					10			
Ag 0.005														25	25									25
Cu 0.06	10																			10				25
Fe 0.3	50					10	25					10		25	50		50		50	50	50		25	50
Pb 0.05	10														50					10	10		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg 0.05 (μg/l)	50				50	10	50								50		25		50	50	50		25	50
Ni 0.05																								
Zn 0.205																					25			10
B 1.00																								

TABLE E-7

Water Quality[1] and Consumption Impacts[2] -- 0 % Loading Assignment Scenario 4 :

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	L	L	L	L	M	L	M	L	M	M
TDS 500																								
TSS 50																								10
SO_4 250																								
NH_3 1.1																								
As 0.05																								
Ba 1.0																								
Cd 0.01																								10
Cl 250																								
Cr 0.01														10	10		10			10	25			25
P 0.05	50					25	50							25	10		25			10	25		10	50
Se 0.01																					10			
Ag 0.005														25	10									25
Cu 0.06	10																							25
Fe 0.3	50					10	25					10		25	50		50			50	50		25	50
Pb 0.05	10														50						10		25	50
Mn 0.05	25											25			50		10			50	50		10	50
Hg (µg/1) 0.05	50				50	10	50							50	50		25			50	50		25	50
Ni 0.05																								
Zn 0.205																					25			
B 1.00																								

TABLE E-8

Water Quality[1] and Consumption Impacts[2] -- 0 % Loading Assignment Scenario 5 :

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	L	M	M
TDS 500																				10				10
TSS 50															10				10					
SO_4 250																								
NH_3 1.1																								
As 0.05																				10				
Ba 1.0																								
Cd 0.01																								10
Cl 250																								
Cr 0.01														10	25		10		25	25	25			50
P 0.05	50					25	50							25	25		25		50	25	25		10	50
Se 0.01																			10		10			
Ag 0.005														25	25				50					25
Cu 0.06	10																		25	10				25
Fe 0.3	50					10	25					10		50	50		50		50	50	50		25	50
Pb 0.05	10														50				10	10	10		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg 0.05 (µg/1)	50				50	10	25							50	50		25		50	50	50		25	50
Ni 0.05																								
Zn 0.205																			10		25			10
B 1.00																								

TABLE E-9

Water Quality[1] and Consumption Impacts[2] -- 0 % Loading Assignment Scenario 6 :

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	L	L	L	L	M	L	M	L	M	M
TDS 500																								
TSS 50																								10
SO_4 250																								
NH_3 1.1																								
As 0.05																								
Ba 1.0																								
Cd 0.01																								10
Cl 250																								
Cr 0.01														10	10									25
P 0.05	50					25	50	10						50	10		25	25			50			25
Se 0.01														10										
Ag 0.005														25			10							25
Cu 0.06	10																							25
Fe 0.3	50					10	10	50						25	50		10	50		25	25		10	50
Pb 0.05	10														25			10						25
Mn 0.05	25							50						25	50			25		50	25			50
Hg 0.05 (µg/1)	50				50	10	50	25						50	50		50	25		50			10	50
Ni 0.05																								
Zn 0.205																								
B 1.00																								

TABLE E-10

Water Quality^1 and Consumption Impacts^2 -- 0 % Loading Assignment Scenario 7 :

Parameter	mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption		M	M	M	L	L	M	M	H	M	M	L	L	H	M	M	M	M	H	M	M	M	M	M	M
TDS	500								25	10					25			10	10	50	25				
TSS	50						10		50	50					10	10	10	25	25	50					10
SO_4	250								25						10					25					
NH_3	1.1								10									10		50					
As	0.05								10											10	25				
Ba	1.0								10											10					
Cd	0.01								50	10					25	10		10	10	50					25
Cl	250																			50					
Cr	0.01								50	50					50	25		50	25	50	25				50
P	0.05	50					50	50	50	50					50	25	10	50	50	50	50	50		10	50
Se	0.01								50	25					25			10	10	50					
Ag	0.005								25						50	25		50		50					50
Cu	0.06	10							50	25					10			10	25	50	10				50
Fe	0.3	50					25	25	50	50					50	50		50	50	50	50	50		25	50
Pb	0.05	10							50	10						50		10	50	25	25			10	50
Mn	0.05	25					10		50	50					25	50		50	50	50	50			25	50
Hg (µg/l)	0.05	50				50	25	50	50	50					50	50		50	50	50	50	50		50	50
Ni	0.05																								
Zn	0.205								50	10								10		50		10			10
B	1.00																								

TABLE E-11

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 1 : (3)

Parameter	mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption		M	M	M	L	L	M	M	M	M	M	L	L	M	M	L	M	L	M	M	M	M	M	M	M
TDS	500								10									10	25		50				
TSS	50						10	10	50								10		50		10				10
SO_4	250								10										10		10				
NH_3	1.1								10										10		10				
As	0.05																				50				
Ba	1.0																								
Cd	0.01								10													10			10
Cl	250																								
Cr	0.01	10	10				10	10	50						25	10	10	25	50		50	25		10	50
P	0.05	50	50				50	50	50				10	25	50	25	50	50	50		50	50	25	25	50
Se	0.01								25										25		10	10			
Ag	0.005								10						25	10									
Cu	0.06	10							50										50		25				25
Fe	0.3	50	10				25	25	50				10		50	50	10	50	50		50	50		25	25
Pb	0.05	10							25						10	25		10	50		50	10		25	50
Mn	0.05	25					10		50				25		50	50		25	50		50	50		25	50
Hg (µg/1)	0.05	50	10			50	25	50	50						50	50	10	50	50		50	50		50	50
Ni	0.05																								
Zn	0.205								50									10	10		10	25			
B	1.00	10	10				10	10	50								10		50		50	10			10

TABLE E-12

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 2 :

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS 500																				10				
TSS 50							10							10	10					10	10			10
SO_4 250																								
NH_3 1.1																			10					
As 0.05																				10				
Ba 1.0																								
Cd 0.01																					10			25
Cl 250																								
Cr 0.01	25	10					10							25	25		10		50	50	25		10	50
P 0.05	50	50				25	50					10	10	50	50		25		50	50	50	25	25	50
Se 0.01																			10	10	10			
Ag 0.005														25	25				50					25
Cu 0.06	10																		25	10				25
Fe 0.3	50	10					10	25					10	50	50		50		50	50	50		25	50
Pb 0.05	10													10	50				10	10	10		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg (µg/1) 0.05	50	10					10	50						50	50		25		50	50	50		50	50
Ni 0.05																								
Zn 0.205																			10		25			10
B 1.00	25	10					10								10				10	25	10			10

TABLE E-13

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 2a:

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	M	M	M	M	M	M	M
TDS 500															10				10	10				
TSS 50							10							10	10				10	10	10			10
SO_4 250																			10					
NH_3 1.1																			10					
As 0.05																				10				
Ba 1.0																								
Cd 0.01															10				10		10			25
Cl 250																								50
Cr 0.01	25	10					10							50	50		10		50	50	25		10	50
P 0.05	50	50				25	50					10	10	50	50	10	25		50	50	50	25	25	10
Se 0.01														10	10				10	10	10			50
Ag 0.005														25	50				50					50
Cu 0.06	10																		25	10				50
Fe 0.3	50	10				10	25					10		50			50		50	50	50		25	50
Pb 0.05	10													10					10	10	10		25	50
Mn 0.05	25											25		50			10		50	50	50		10	50
Hg 0.05 (μg/1)	50	10			50	10	50							50			25		50	50	50		25	
Ni 0.05																								
Zn 0.205																			10	10	25			10
B 1.00	25	10					10							10					25	25	10			10

TABLE E-14

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 2b: (3)

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS 500							10													10	10			
TSS 50							10							10	10					10	10			10
SO_4 250																					10			
NH_3 1.1																			10		10			
As 0.05																				10				
Ba 1.0																								
Cd 0.01																					10			25
Cl 250																								
Cr 0.01	25	10					10							25	25		10		50	50	50		10	50
P 0.05	50	50			10	25	50					10	10	50	50	10	25		50	50	50	25	25	50
Se 0.01																			10	10	25			10
Ag 0.005														25	25				50					50
Cu 0.06	10																		25	10	10			50
Fe 0.3	50	10				10	25					10		50	50		50		50	50	50		25	50
Pb 0.05	10													10	50				10	25	25		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg 0.05 (μg/l)	50	10			50	10	50					10	25	50	50	10	25		50	50	50		25	50
Ni 0.05																								
Zn 0.205																			10	10	50			10
B 1.00	25	10					10								10				10	25	25			10

TABLE E-15

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 2c:

Parameter	mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS	500	10						10													10				10
TSS	50							10	10																
SO_4	250																					10			
NH_3	1.1	10																							
As	0.05																								
Ba	1.0																								
Cd	0.01																								10
Cl	250																								
Cr	0.01	25	10					25	10					10	25	10		10			25	50	25		50
P	0.05	50	50			10	25	50	10					50	50	25	10	25	50		25	50	50	10	50
Se	0.01														10										
Ag	0.005														25			10							25
Cu	0.06	25				10																			25
Fe	0.3	50	10			10	10	25	50					10	25	50		10	50		50	50	10	10	50
Pb	0.05	25														25			10		10		10		50
Mn	0.05	50							50						25	50			25		50	50			
Hg (µg/1)	0.05	50	10			50	10	50	25						50	50		50	25		50	25		10	50
Ni	0.05																								
Zn	0.205																					10			10
B	1.00	50	10					25						10								50	10		10

:

TABLE E-16

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 3 :

(3)

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	L	M	M
TDS 500																				10				10
TSS 50							10								10						10			
SO_4 250																								
NH_3 1.1																								
As 0.05																				10				
Ba 1.0																								
Cd 0.01																					10			10
Cl 250																								
Cr 0.01	10	10					10							25	25		10		10	25	25		10	50
P 0.05	50	50				25	50					10	10	25	50	10	25		25	50	50	25	25	50
Se 0.01																				10	10			
Ag 0.005														25	25									25
Cu 0.06	10																			10				
Fe 0.3	50													50	50		50		50	50	50		25	50
Pb 0.05	10	10				10	25					10		50	50					10	10		25	50
Mn 0.05	25														50		10		50	50	50		10	50
Hg 0.05 (µg/1)	50	10			50	10	50					25		50	50		25		50	50	50		25	50
Ni 0.05																								
Zn 0.205																					25			10
B 1.00	25	10					10								10					25	10			10

TABLE E-17

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 4 : (3)

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	L	L	L	L	M	L	M	L	M	M
TDS 500																								
TSS 50							10														10			10
SO_4 250																								
NH_3 1.1																								
As 0.05																								
Ba 1.0																								
Cd 0.01																					10			
Cl 250																								
Cr 0.01	10	10					10							25	25		10			25	25		10	25
P 0.05	50	50				25	50					10	10	25	25	10	25			25	50		25	50
Se 0.01																					10			
Ag 0.005														25	10									25
Cu 0.06	10																							25
Fe 0.3	50	10				10	25					10		50	50		50			50	50		25	50
Pb 0.05	10														50						10		25	50
Mn 0.05	25											25			50		10			50	50		10	50
Hg 0.05 (µg/1)	50	10			50	10	50							50	50		25			50	50		25	50
Ni 0.05																								
Zn 0.205																					25			
B 1.00	10	10					10													10	10			

TABLE E-18

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 5 :

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14	(3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	L	M	M	
TDS 500																				10					
TSS 50							10								10						10			10	
SO_4 250																									
NH_3 1.1																			10						
As 0.05																				10					
Ba 1.0																									
Cd 0.01																					10			10	
Cl 250																									
Cr 0.01	10	10					10							25	25		10		50	25	25		10	50	
P 0.05	10	50				25	50					10	10	25	50	10	25		50	50	50		25	50	
Se 0.01																			10	10	10				
Ag 0.005														25	25				50		50			25	
Cu 0.06	10																		25	10				25	
Fe 0.3	50	10				10	25					10		50	50		50		50	50			25	50	
Pb 0.05	10														50				10	10	10		25	50	
Mn 0.05	25											25		50	50		10		50	50	50		10	50	
Hg 0.05 (µg/1)	50	10			50	10	50							50	50		25		50	50	50		25	50	
Ni 0.05																									
Zn 0.205																			10		25			10	
B 1.00	25	10					10								10				10	25	10			10	

TABLE E-19

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 6 : (3)

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption																								
TDS 500																								10
TSS 50																								
SO_4 250																								
NH_3 1.1																								
As 0.05																								
Ba 1.0																								
Cd 0.01																								10
Cl 250																								
Cr 0.01	10	10					10						10	25	10		10			10	50	10		25
P 0.05	50	50				25	50	10					50	50	25	10	25	50		10	50	50	10	50
Se 0.01														10										
Ag 0.005														25			10							25
Cu 0.06	10																							25
Fe 0.3	50	10				10	25	50					10	10	50		10	50		25	50	10	10	50
Pb 0.05	10														25			10						25
Mn 0.05	25							50						25	50			25		50	25			50
Hg 0.05 (µg/1)	50	10			50	10	50	25						50	50		50	25		50	25			50
Ni 0.05																								
Zn 0.205																								
B 1.00	10												10								50	10		

TABLE E-20

Water Quality[1] and Consumption Impacts[2] -- 5 % Loading Assignment Scenario 7 : (3)

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption	M	M	M	L	L	M	M	H	M	M	L	L	H	M	M	M	M	H	M	M	M	M	M	M
TDS 500							10	50	10					25			10	10	50	25				
TSS 50						10	10	50	50					25	10	10	25	25	50					10
SO_4 250								50						10					50	10	10			
NH_3 1.1								25						10			10		50	10				
As 0.05								25											10	25				
Ba 1.0								10											10					
Cd 0.01								50	10					25	10		10	10	50					25
Cl 250																			10					
Cr 0.01	25	10				10	25	50	50				25	50	50		50	25	50	50	50	10	10	50
P 0.05	50	50				50	50	50	50				50	50	50	25	50	50	50	50	50	50	50	50
Se 0.01								50	25					25			25	10	50					
Ag 0.005								25						50	25		50		50					50
Cu 0.06	10							50	25					10			10	25	50	10				50
Fe 0.3	50	10				25	25	50	50				25	50	50		50	50	50	50	50	10	25	50
Pb 0.05	10							50	10						50		10	50	25	25			10	50
Mn 0.05	25					10		50	50					25	50		50	50	50	50	50		25	50
Hg (µg/1) 0.05	50	10			50	25	50	50	50				10	50	50		50	50	50	50	50	10	50	50
Ni 0.05																								
Zn 0.205								50	10								10		50		10			10
B 1.00	25	10				10	25	50					25	50	10		50	10	50	50	50	25	10	10

TABLE E-21

Water Quality[1] and Consumption Impacts[2] --100 % Loading Assignment Scenario 1 :

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	M	M	M	M	L	L	M	M	L	M	L	M	M	M	M	M	M	M
TDS 500	10	10				10	10	50						10		25	10	50		50	25	10	10	10
TSS 50	10	10				25	25	50					10	10	10	25	10	50		50	25	10	10	25
SO_4 250	25	25				25	25	50					10	10	10	25	10	50		50	25	10	10	10
NH_3 1.1	10	25				10	25	50					10	10	10	25	10	50		50	25	10	10	10
As 0.05								25										25		50	10			
Ba 1.0																								
Cd 0.01						10		25										50		10	10			10
Cl 250				25				10										10		25				
Cr 0.01	50	50			10	50	50	50				25	50	50	50	50	50	50		50	50	50	50	50
P 0.05	50	50		50	50	50	50	50				50	50	50	50	50	50	50		50	50	50	50	50
Se 0.01		25				10	25	50					10	10	10	25	10	50		50	25	10	10	10
Ag 0.005								25						25	10			25		25				25
Cu 0.06	10	10				10	10	50								10	10	50		50	25			25
Fe 0.3	50	50		25		50	50	50				25	50	50	50	50	50	50		50	50	50	50	50
Pb 0.05	10							25						10	25		10	50		50	10		25	50
Mn 0.05	25					10		50				25		50	50		25	50		50	50		25	50
Hg (µg/1) 0.05	50	50		10	50	50	50	50				10	50	50	50	50	50	50		50	50	50	50	50
Ni 0.05																								
Zn 0.205		10					10	50								10	10	25		50	25		10	10
B 1.00	50	50		25	10	50	50	50				25	50	50	50	50	50	50		50	50	50	50	50

TABLE E-22

Water Quality[1] and Consumption Impacts[2] --100 % Loading Assignment Scenario 2 :

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS 500	25	10					10							10	10				25	25	25	10		10
TSS 50	25	10				10	25							10	25		10		25	25	25	10	10	25
SO_4 250	50	25				10	25						10	10	25				25	25	25	10	10	25
NH_3 1.1	25	25				10	25						10	10	10				25	25	25	10	10	10
As 0.05																			10	25	10			
Ba 1.0																								
Cd 0.01															10				10		10			25
Cl 250																								
Cr 0.01	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50	50	50	50
P 0.05	50	50		50	50	50	50					50	50	50	50	50	50		50	50	50	50	50	50
Se 0.01	10	25					25						10	10	10				25	25	25	10	10	10
Ag 0.005														25	25				50					50
Cu 0.06	10	10					10								10				25	25	25			50
Fe 0.3	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50	50	50	50
Pb 0.05	10													10	50				10	10	10		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg 0.05 (µg/1)	50	50		10	50	50	50					10	50	50	50	25	50		50	50	50	50	50	50
Ni 0.05																								
Zn 0.205		10					10								10				10	10	25			10
B 1.00												25	50	50	50	50	50		50	50	50	50	50	50

TABLE E-23

Water Quality[1] and Consumption Impacts[2] -- 100% Loading Assignment Scenario 2a :

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	M	M	M	M	M	M	M
TDS 500	25	10					10							25	25				25	25	25	10		10
TSS 50	25	10				10	25							25	25		10		25	25	25	10	10	25
SO_4 250	50	25				10	25						10	25	25				50	50	25	10	10	25
NH_3 1.1	25	25				10	25						10	25	25				50	25	25	10	10	25
As 0.05																			10	25	10			
Ba 1.0																								
Cd 0.01														10	10				10	10	10			25
Cl 250																			10					
Cr 0.01	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50	50	50	50
P 0.05	50	50		50	50	50	50					50	50	50	50	50	50		50	50	50	50	50	50
Se 0.01	10	25					25						10	25	25				50	25	25	10	10	25
Ag 0.005														25	50				50	10				50
Cu 0.06	10	10					10							10	10				50	25	25			50
Fe 0.3	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50	50	50	50
Pb 0.05	10													10	50				10	10	10		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg 0.05 (µg/1)	50	50		10	50	50	50					10	50	50	50	25	50		50	50	50	50	50	50
Ni 0.05																								
Zn 0.205		10					10							10	10				25	10	25			10
B 1.00	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50	50	50	50

TABLE E-24

Water Quality[1] and Consumption Impacts[2] --100 % Loading Assignment Scenario 2b:

(3)

Parameter	mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS	500	25	10					10							10	10				25	25	25	10		10
TSS	50	25	10				10	25							10	25		10		25	25	50	10	10	25
SO_4	250	50	25				10	25						10	10	25				25	50	50	10	10	25
NH_3	1.1	25	25				10	25						10	10	10				25	25	50	10	10	25
As	0.05																			10	25	10			
Ba	1.0																								
Cd	0.01															10				10	10	10			25
Cl	250																								
Cr	0.01	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50	50	50	50
P	0.05	50	50		50	50	50	50					50	50	50	50	50	50		50	50	50	50	50	50
Se	0.01	10	25					25						10	10	10				25	25	50	10	10	25
Ag	0.005														25	25				50	10	10			50
Cu	0.06	10	10					10								10				25	25	25	50		50
Fe	0.3	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50		50	50
Pb	0.05	10													10	50				10	25	25		25	50
Mn	0.05	25											25		50	50		10		50	50	50		10	50
Hg (µg/l)	0.05	50	50		10	50	50	50					10	50	50	50	25	50		50	50	50	50	50	50
Ni	0.05																								
Zn	0.205		10					10								10				10	25	50			10
B	1.00	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50	50	50	50

TABLE E-25

Water Quality[1] and Consumption Impacts[2] --100 % Loading Assignment Scenario 2c:

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14	(3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M	
TDS 500	50	10					25						10	10						10	50	25		10	
TSS 50	25	10				10	25	10					10	10	10			10		10	50	25		25	
SO_4 250	50	25				10	50						25	10	10					10	50	50		10	
NH_3 1.1	50	25					50						25	10						10	50	50		10	
As 0.05																					25	10			
Ba 1.0																									
Cd 0.01																					10			10	
Cl 250	10																				25				
Cr 0.01	50	50		25	25	50	50	10					50	50	50	25	50	50		50	50	50	25	50	
P 0.05	50	50		50	50	50	50	10					50	50	50	50	50	50		50	50	50	50	50	
Se 0.01		25					10						10	25	10					10	50	25		10	
Ag 0.005														25			10				25			25	
Cu 0.06	25	10			10		10						10					10			50	10		25	
Fe 0.3	50	50		10	10	50	50	50					50	50	50	25	50	50		50	50	50	25	50	
Pb 0.05	25														25			10		10				50	
Mn 0.05	50							50						25	50			25		50	50			50	
Hg (µg/1) 0.05	50	50			50	50	50	25					50	50	50	25	50	50		50	50	50	25	50	
Ni 0.05																									
Zn 0.205		10																		10	25	10		10	
B 1.00	50	50		50	25	50	50						50	50	50	50	50	50		50	50	50	25	50	

TABLE E-26

Water Quality[1] and Consumption Impacts[2] -- 100% Loading Assignment Scenario 3 :

(3)

Parameter	mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	L	M	M
TDS	500	25	10					10							10	10					25	25	10		10
TSS	50	10	10				10	25							10	25		10		10	25	25	10	10	25
SO_4	250	25	25				10	25						10	10	25				10	25	25	10	10	10
NH_3	1.1	25	25				10	25						10	10	10				10	25	25	10	10	10
As	0.05																				25	10			
Ba	1.0																								
Cd	0.01															10						10			10
Cl	250																								
Cr	0.01	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50	50	50	50
P	0.05	50	50		50	50	50	50					50	50	50	50	50	50		50	50	50	50	50	50
Se	0.01	10	25					25						10	10	10				10	25	25	10	10	10
Ag	0.005														25	25									25
Cu	0.06	10	10					10								10				10	25	25			25
Fe	0.3	50	50		25		50	50					25	50	50	50	50	50		50	50	50	50	50	50
Pb	0.05	10														50					10	10		25	50
Mn	0.05	25											25			50		10		50	50	50		10	50
Hg (µg/1)	0.05	50	50		10	50	50	50					10	50	50	50	25	50		50	50	50	50	50	50
Ni	0.05																								
Zn	0.205		10					10								10					10	25			25
B	1.00	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50	50	50	50

TABLE E-27

Water Quality[1] and Consumption Impacts[2] -- 100% Loading Assignment Scenario 4: (3)

Parameter	mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	L	L	L	L	M	L	M	L	M	M
TDS	500	10	10					10							10	10					10	25			10
TSS	50		10				10	25							10	10		10			10	25		10	10
SO_4	250	10	25				10	25						10	10	10					10	25		10	10
NH_3	1.1	10	25				10	25						10	10	10					10	25		10	10
As	0.05																					10			
Ba	1.0																								
Cd	0.01																					10			10
Cl	250																								
Cr	0.01	50	50				50	50					25	50	50	50	50	50			50	50		50	50
P	0.05	50	50			25	50	50					50	50	50	50	50	50			50	50		50	50
Se	0.01		25					25						10	10	10					10	25		10	10
Ag	0.005														25	10									25
Cu	0.06	10	10					10													10	25			25
Fe	0.3	50	50				50	50					25	50	50	50	50	50			50	50		50	50
Pb	0.05	10														50						10		25	50
Mn	0.05	25	50													50		10			50	50		10	50
Hg (µg/1)	0.05	50				50	50	50					25	50	50	50	25	50			50	50		50	50
Ni	0.05												10												
Zn	0.205		10					10													10	25			10
B	1.00	50	50			10	50	50					25	50	50	50	50	50			50	50		50	50

TABLE E-28

Water Quality[1] and Consumption Impacts[2] --100 % Loading Assignment Scenario 5 :

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	L	M	M
TDS 500	25	10					10							10	10				25	25	25			10
TSS 50	10	10				10	25							10	25		10		25	25	25		10	25
SO_4 250	25	25				10	25						10	10	25				25	25	25		10	25
NH_3 1.1	25	25				10	25						10	10	10				25	25	25		10	10
As 0.05																			10	25	10			
Ba 1.0																								
Cd 0.01															10				10		10			25
Cl 250																								
Cr 0.01	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50		50	50
P 0.05	50	50		50	50	50	50					50	50	50	50	50	50		50	50	50		50	50
Se 0.01	10	25					25						10	10	10				25	25	25		10	10
Ag 0.005														25	25				50					25
Cu 0.06	10	10					10								10				25	25	25			50
Fe 0.3	50	50		25	10	50	50					25	50	50	50	50	50		50	50	50		50	50
Pb 0.05	10														50				10	10	10		25	50
Mn 0.05	25											25		50	50		10		50	50	50		10	50
Hg (µg/1) 0.05	50	50		10	50	50	50					10	50	50	50	25	50		50	50	50		50	50
Ni 0.05																								
Zn 0.205		10					10								10				10	10	25			10
B 1.00	50	50		25	50	50	50					25	50	50	50	50	50		50	50	50		50	50

TABLE E-29

Water Quality[1] and Consumption Impacts[2] -- 100 % Loading Assignment Scenario 6 :

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	L	L	L	L	M	L	M	L	M	M
TDS 500	10	10					10						10	10							50	10		10
TSS 50	10	10				10	10						10	10	10			10			50	10		10
SO_4 250	25	25				10	25						25	10	10						50	25		10
NH_3 1.1	10	25					10						25	10							50	25		10
As 0.05																					25			
Ba 1.0																								
Cd 0.01																					10			10
Cl 250																					10			
Cr 0.01	50	50				50	50						50	50	50	25	50	50		50	50	50	25	50
P 0.05	50	50			25	50	50	10					50	50	50	50	50	50		50	50	50	50	50
Se 0.01		25					10						10	25	10						50	25		10
Ag 0.005														25			10				25			25
Cu 0.06	10	10					10						10					10			50	10		25
Fe 0.3	50	50				50	50	50					50	50	50	25	50	50		50	50	50	25	50
Pb 0.05	10														25			10						25
Mn 0.05	25							50						25	50			25		50	25			50
Hg 0.05 (µg/l)	50	50			50	50	50	25					50	50	50	25	50	50		50	50	50	25	30
Ni 0.05																								
Zn 0.205		10																						10
B 1.00	50	50				50	50						50	50	50	50	50	50		50	50	50	25	50

TABLE E-30

Water Quality[1] and Consumption Impacts[2] -- 100 % Loading Assignment Scenario 7 : (3)

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption	M	M	M	L	L	M	M	H	M	M	L	L	H	M	M	M	M	H	M	M	M	M	M	M
TDS 500	25	10				10	25	50	10				50	50	25		50	25	50	50	50	25	10	10
TSS 50	25	10				25	50	50	50				50	50	25	10	50	50	50	50	50	25	10	25
SO_4 250	50	25				25	50	50					50	50	25		50	25	50	50	50	25	25	25
NH_3 1.1	25	25				10	50	50					50	50	25		50	25	50	50	50	25	25	25
As 0.05							10	50					10	50	10		25		50	50	50	10		
Ba 1.0								25											25					
Cd 0.01						10		50	10					25	10		25	25	50	10	10			25
Cl 250							10	50					10	25			10		50	25	25			
Cr 0.01	50	50		25	10	50	50	50	50				50	50	50	25	50	50	50	50	50	50	50	50
P 0.05	50	50		50	50	50	50	50	50				50	50	50	50	50	50	50	50	50	50	50	50
Se 0.01	10	25				10	50	50	25				50	50	25		50	25	50	50	50	25	25	25
Ag 0.005							10	50					10	50	25		50		50	25	25			50
Cu 0.06	10	10				10	25	50	25				25	50	10		50	50	50	50	50	10	10	50
Fe 0.3	50	50		25	10	50	50	50	50				50	50	50	25	50	50	50	50	50	50	50	50
Pb 0.05	10							50	10						50		10	50	25	25			10	50
Mn 0.05	25					10		50	50					25	50		50	50	50	50	50		25	50
Hg 0.05 (µg/1)	50	50		10	50	50	50	50	50				50	50	50	25	50	50	50	50	50	50	50	50
Ni 0.05								10																
Zn 0.205		10					10	50	10				10	50	10		25	10	50	50	50	10	10	50
B 1.00	50	50		25	10	50	50	50					50	50	50	50	50	50	50	50	50	50	50	50

Table E-31 Conjured and Planned Installed Capacities of Power Generating Facilities in ORBES Region River Basins

STATES	SCENARIOS					
	1	2	2a	2b	2c	3
Illinois	1950	5200	5200	6200	13000	2600
Big Muddy	0	0	0	0	0	0
Kaskaskia	0	0	0	0	0	0
Rock	1300	1300	1300	1300	2000	1300
Mississippi	(1300)* 4550	(1300)* 7800	(1300)* 7800	(1300)* 8800	(5300)* 20294	(650)* 4550
White	1950	0	0	0	0	0
Wabash	5850	2600	2600	2600	2300	2600
Big Sandy	650	0	0	0	0	0
Licking	0	0	0	0	0	0
Salt	0	0	0	0	0	0
Cumberland	0	0	0	0	0	0
Green	0	0	0	0	0	0
Kentucky	0	0	0	0	0	0
Scioto	1300	1300	2600	1300	0	0
Muskingum	0	1950	3250	1950	650	1950
Whitewater	650	0	0	0	0	0
Great Miami	650	0	0	0	0	0
Little Miami	650	0	0	0	0	0
Beaver	0	1950	2600	1950	0	650
Allegheny	7150	4550	7150	8550	1650	3250
Monongahela	1950	1950	1950	3950	3949	1950
Susquehanna	650	650	650	650	0	650
Kanawha	650	0	0	0	0	0
Ohio	(29900)* 51350	(46800)* 61100	(61100)* 81250	81100	53788	(31850)* 42250

*Values for the Mississippi and Ohio Main stems alone.

Table E- 31 continued

STATES	SCENARIOS					
	4	5	6	7		
Illinois	650	3250	0	5850	14955	15173
Big Muddy	0	0	0	0	346	
Kaskaskia	0	0	0	0	0	
Rock	0	1300	0	1300	0	
Mississippi	(650)* 1300	(1300)* 5850	(650)* 650	(1300)* 8450	5450	
White	0	0	0	1950	2835	471
Wabash	2600	2600	650	6850	6932	7996
Big Sandy	0	0	0	1300	0	
Licking	0	0	0	0	0	
Salt	0	0	0	0	0	
Cumberlane	0	0	0	0	0	
Green	0	0	0	0	480	0
Kentucky	0	0	0	3250	440	920
Scioto	0	650	0	1300	90	
Muskingum	650	1950	650	3250	1826	1606
Whitewater	0	0	0	1300	160	220
Great Miami	0	0	0	2600	702	160
Little Miami	0	0	0	1300	0	702
Beaver	0	1950	0	2600	0	
Allegheny	650	3250	0	4550	5659	1890
Monongahela	1950	1950	1300	2600	2470	3769
Susquehana	0	0	0	1300	0	2470
Kanawha	0	0	0	2600	4231	1300
Ohio	(16250) 22100	(40300)* 50700	(11700)* 13000	(56550)*	65732	68663

*Values for the Mississippi and Ohio main stems alone.

APPENDIX F

Explanation notes for Tables F-1 to F-11

[1] Tables 1-3 list the reference standards used in the ORBES study to compare increments in ambient concentrations of constituents. These standards are based on current legal statutes but may not be exactly the same as state standards for a given river. Designations in Tables F-1 to F-11 are as follows: Blank - if overall stream reaches the total of background plus incremental additions due to plant loading and consumption is less than or equal to the reference standard, 10 - if this sum is $\geq 10\%$ of the standard but $< 25\%$, 25 - if this sum is $\geq 25\%$ of the standard but $< 50\%$, 50 - if this sum is $\geq 50\%$ of the standard.

[2] Water consumption impacts are designated as light (L) if the portion of 7-day, 10-year low flow consumed is $< 10\%$; moderate (M) if this portion is $\geq 10\%$ but $< 25\%$ and; heavy (H) if $> 25\%$.

[3] Figure 1-2 map numbers.

[4] An event circled as ㊿ , ㉕ , or ⑩ indicates impacts occurring in addition to those noted for 1976 7Q10 conditions in Table F-1. Spaces designated in Table F-2 (Scenario 1) with Figure ◇ indicate the removal of an impact event observed for 1976 7Q10 conditions.

TABLE F-1

Water Quality[1] and Consumption Impacts[2] -- 1976 7-Day-10 Year Low Flow

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS 500	10			/						/			/			/						/		
TSS 50				/		50		50	50	/		25	/	50	50	/	50	50				/		50
SO_4 250				/						/			/			/						/		
NH_3 1.1				/						/			/			/						/		
As 0.05				/						/			/			/						/		
Ba 1.0				/						/			/			/						/		
Cd 0.01				/						/	50		/		25	/	10	50				/		
Cl 250				/						/			/			/						/		
Cr 0.01				/				50	50	/		50	/	50	50	/	50	50	50	50	50	/	50	50
P 0.05	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Se 0.01				/						/			/	10		/						/		
Ag 0.005				/						/	50	50	/			/	10					/		50
Cu 0.06				/	25			50		/			/			/	50	50	50			/		
Fe 0.3	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Pb 0.05				/				10		/		50	/	50	50	/	50	50		10		/	50	50
Mn 0.05	50	50	50	/	50	50		50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Hg 0.05 (µg/1)				/		50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Ni 0.05				/						/			/			/						/		
Zn 0.205				/				25		/			/			/	50				50	/	10	
B 1.00	25			/						/			/			/						/		

TABLE F-2

Water Quality[1] and Consumption Impacts[2] -- 5% Loading Assignment Scenario 1 :

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	M	M	M	M	L	L	M	M	L	M	L	M	M	M	M	M	M	M
TDS 500	◇			╱						╱			╱			╱						╱		
TSS 50				╱		◇		50	◇	╱		◇	╱	◇	◇	╱	◇	50				╱		◇
SO_4 250				╱						╱			╱			╱						╱		
NH_3 1.1				╱						╱			╱			╱						╱		
As 0.05				╱						╱			╱			╱						╱		
Ba 1.0				╱						╱			╱			╱						╱		
Cd 0.01				╱						╱	◇		╱		◇	╱	◇	10				╱		
Cl 250				╱						╱			╱			╱						╱		
Cr 0.01				╱				50	◇	╱		◇	╱	50	50	╱	◇	50	50	50	◇	╱	◇	25
P 0.05	50	50	50	╱	50	50	50	50	50	╱	50	50	╱	50	50	╱	50	50	50	50	50	╱	50	50
Se 0.01				╱						╱			╱	◇		╱						╱		
Ag 0.005				╱						╱	50	50	╱			╱	◇					╱		50
Cu 0.06				╱	◇			25		╱			╱			╱	◇	50	◇			╱		
Fe 0.3	50	50	50	╱	50	50	50	50	50	╱	50	50	╱	50	50	╱	50	50	50	50	50	╱	50	50
Pb 0.05				╱				◇		╱		◇	╱	◇	50	╱	25	50		◇		╱	50	50
Mn 0.05	50	50	50	╱	50	50		50	◇	╱	50	50	╱	50	50	╱	50	50	50	50	50	╱	50	50
Hg 0.05 (µg/1)				╱		50	50	50	50	╱	50	50	╱	50	50	╱	50	50	50	50	50	╱	50	50
Ni 0.05				╱						╱			╱			╱						╱		
Zn 0.205				╱				◇		╱			╱			╱	25				50	╱	◇	
B 1.00	◇			╱						╱			╱			╱						╱		

TABLE F-3

Water Quality[1] and Consumption Impacts[2] -- 100 % Loading Assignment Scenario 2

Parameter	mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS	500	10	⑩													⑩									
TSS	50						50		50	50			25		50	50		50	50		⑩				50
SO_4	250		⑩																						
NH_3	1.1																			㉕					
As	0.05																								
Ba	1.0																								
Cd	0.01											50				25		10	50						
Cl	250																								
Cr	0.01	㊿	㊿				㊿		50	50			50		50	50		50	50	50	50	50		50	50
P	0.05	50	50	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Se	0.01														10	⑩					㉕	㉕		⑩	
Ag	0.005											50	50					10							50
Cu	0.06					25		50	50									50	50	50					⑩
Fe	0.3	50	50	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Pb	0.05								10				50		50	50		50	50		25	⑩		50	50
Mn	0.05	50	50	50		50	50		50	50		50	50		50	50		50	50	50	50	50		50	50
Hg (µg/1)	0.05	㊿	㊿				50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Ni	0.05																								
Zn	0.205								25									50		⑩	⑩	50		㉕	
B	1.00	㊿	㊿																						

TABLE F-4

Water Quality[1] and Consumption Impacts[2] -- 100% Loading Assignment Scenario 2a :

(3)

Parameter	mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	M	M	M	M	M	M	M
TDS	500	10	⑩													⑩									
TSS	50						50		50	50			25		50	50		50	50		⑩				50
SO_4	250		⑩																						
NH_3	1.1																			㉕					
As	0.05																								
Ba	1.0																								
Cd	0.01											50				50		10	50						
Cl	250																								
Cr	0.01	㊿	㊿				㊿		50	50			50		50	50		50	50	50	50	50		50	50
P	0.05	50	㊿	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Se	0.01														10	⑩					㉕	㉕		⑩	
Ag	0.005											50	50					10							50
Cu	0.06					25		50	50									50	50	50					50
Fe	0.3	50	50	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Pb	0.05								10				50		50	50		50	50	10	25	10		50	50
Mn	0.05	50	50	50		50	50		50	50		50	50		50	50		50	50	50	50	50		50	50
Hg (µg/l)	0.05	㊿	㊿				50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Ni	0.05																								
Zn	0.205								25									50		⑩	⑩	50		㉕	
B	1.00	㊿	㊿												50						50				

TABLE F-5

Water Quality[1] and Consumption Impacts[2] -- 100% Loading Assignment Scenario 2b :

Parameter	mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	M	M	M
TDS	500	10	⑩													⑩									
TSS	50						50		50	50			25		50	50		50	50		⑩	10			50
SO_4	250		⑩																			25			
NH_3	1.1																			㉕		10			
As	0.05																								
Ba	1.0																								
Cd	0.01											50			25			10	50						
Cl	250																								
Cr	0.01	㊿	㊿				㊿		50	50			50		50	50		50	50	50	50	50		50	50
P	0.05	50	50	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Se	0.01														10	⑩					50	50		⑩	
Ag	0.005											50	50					10							50
Cu	0.06					25		50	50									50	50	50					25
Fe	0.3	50	50	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Pb	0.05								10				50		50	50		50	50		25	25		50	50
Mn	0.05	50	50	50		50	50		50	50		50	50		50	50		50	50	50	50	50		50	50
Hg (µg/1)	0.05	50	㊿				50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Ni	0.05																								
Zn	0.205								25									50		⑩	50	50		㉕	
B	1.00	50	㊿																						

TABLE F-6

Water Quality[1] and Consumption Impacts[2] -- 100 % Loading Assignment Scenario 2c:

Parameter mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	L	L	M	M	L	L	M	M	L	L	L	M	M	M	M	M	M	M
TDS 500	25	⑩		/			25			/			/		⑩	/						/		
TSS 50				/		50	10	50	50	/		25	/	50	50	/	50	50		⑩	10	/		50
SO_4 250	10	⑩		/						/			/			/					25	/		
NH_3 1.1				/						/			/			/			㉕		10	/		
As 0.05				/						/			/			/						/		
Ba 1.0				/						/			/			/						/		
Cd 0.01				/			10			/	50		/		25	/	10	50				/		
Cl 250				/						/			/			/						/		
Cr 0.01	㊿	㊿		/		㊿		50	50	/		50	/	50	50	/	50	50	50	50	50	/	50	50
P 0.05	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Se 0.01				/						/			/	10	⑩	/				㉕	50	/	⑩	
Ag 0.005				/						/	50	50	/			/	10					/		50
Cu 0.06				/	25		25	50		/			/			/	50	50	50			/		⑩
Fe 0.3	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Pb 0.05				/				10		/		50	/	50	50	/	50	50		25	25	/	50	50
Mn 0.05	50	50	50	/	50	50		50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Hg 0.05 (µg/l)	㊿	㊿		/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Ni 0.05				/						/			/			/						/		
Zn 0.205				/				25		/			/			/	50		⑩	⑩	50	/	㉕	
B 1.00	㊿	㊿		/						/			/			/						/		

TABLE F-7

Water Quality[1] and Consumption Impacts[2] -- 100% Loading Assignment Scenario 3 : (3)

Parameter	mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	L	M	M
TDS	500	10	⑩													⑩									
TSS	50						50		50	50			25		50	50		50	50		⑩				50
SO_4	250		⑩																						
NH_3	1.1																			㉕					
As	0.05																								
Ba	1.0																								
Cd	0.01											50				25		10	50						
Cl	250																								
Cr	0.01	㊿	㊿				㊿		50	50			50		50	50		50	50	50	50	50		50	50
P	0.05	50	50	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Se	0.01														10	⑩					㉕	㉕		⑩	
Ag	0.005											50	50						10						50
Cu	0.06					25		50	50									50	50	50					10
Fe	0.3	50	50	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Pb	0.05								10				50		50	50		50	50		25	⑩		50	50
Mn	0.05	50	50	50		50	50		50	50		50	50		50	50		50	50	50	50	50		50	50
Hg (µg/1)	0.05	㊿	㊿				50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Ni	0.05																								
Zn	0.205								25									50		⑩	⑩	50		㉕	
B	1.00	㊿	㊿																						

TABLE F-8

Water Quality[1] and Consumption Impacts[2] -- 100 % Loading Assignment Scenario 4 :

(3)

Parameter	mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	L	L	L	L	M	L	M	L	M	M
TDS	500	10	⑩		/						/			/		⑩	/						/		
TSS	50				/		50		50	50	/		25	/	50	50	/	50	50		⑩		/		50
SO_4	250		⑩		/						/			/			/						/		
NH_3	1.1				/						/			/			/			㉕			/		
As	0.05				/						/			/			/						/		
Ba	1.0				/						/			/			/						/		
Cd	0.01				/						/	50		/		25	/	10	50				/		
Cl	250				/						/			/			/						/		
Cr	0.01	㊿	㊿		/		㊿		50	50	/		50	/	50	50	/	50	50	50	50	50	/	50	50
P	0.05	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Se	0.01				/						/			/	10	⑩	/				⑩	㉕	/	⑩	
Ag	0.005				/						/	50	50	/			/	10					/		50
Cu	0.06				/	25		50	50		/			/			/	50	50	50			/		⑩
Fe	0.3	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Pb	0.05				/				10		/		50	/	50	50	/	50	50		25	⑩	/	50	50
Mn	0.05	50	50	50	/	50	50		50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Hg (µg/1)	0.05	㊿	㊿		/		50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Ni	0.05				/						/			/			/						/		
Zn	0.205				/				25		/			/			/	50		⑩	⑩	50	/	㉕	
B	1.00	㊿	㊿		/						/			/			/						/		

TABLE F - 9

Water Quality[1] and Consumption Impacts[2] -- 100% Loading Assignment Scenario 5 :

Parameter	mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	M	L	L	L	M	M	M	L	M	M
TDS	500	10	⑩		/						/			/			/						/		
TSS	50				/		50		50	50	/		25	/	50		/	50	50		⑩		/		50
SO_4	250		⑩		/						/			/			/						/		
NH_3	1.1				/						/			/			/			㉕			/		
As	0.05				/						/			/			/						/		
Ba	1.0				/						/			/			/						/		
Cd	0.01				/						/	50		/			/	10	50				/		
Cl	250				/						/			/			/						/		
Cr	0.01	㊿	㊿		/		㊿		50	50	/		50	/	50	50	/	50	50	50	50	50	/	50	50
P	0.05	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Se	0.01				/						/			/	10	⑩	/				㉕	㉕	/	⑩	
Ag	0.005				/						/	50	50	/			/	10					/		50
Cu	0.06				/	25		50	50		/			/			/	50	50	50			/		⑩
Fe	0.3	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Pb	0.05				/				10		/		50	/	50	50	/	50	50		25	⑩	/	50	50
Mn	0.05	50	50	50	/	50	50		50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Hg (µg/1)	0.05	㊿	㊿		/		50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Ni	0.05				/						/			/			/						/		
Zn	0.205				/				25		/			/			/	50		⑩	⑩	50	/	㉕	
B	1.00	㊿	㊿		/						/			/			/						/		

TABLE F - 10

Water Quality[1] and Consumption Impacts[2] -- 100% Loading Assignment Scenario 6 : (3)

Parameter	mg/l	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14
Water Consumption		M	M	M	L	L	M	L	L	M	M	L	L	M	M	L	L	L	L	M	L	M	L	M	M
TDS	500	10	⑩													⑩									
TSS	50						50	25	50	50			25		50	50		50	50		⑩				50
SO_4	250		⑩																						
NH_3	1.1																			㉕					
As	0.05																								
Ba	1.0																								
Cd	0.01											50				25		10	50						
Cl	250																								
Cr	0.01	㊿	㊿	50			㊿		50	50		50	50		50	50		50	50	50	50	50		50	50
P	0.05	50	50	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Se	0.01														10	⑩					10	㉕		⑩	
Ag	0.005											50	50					10	10						50
Cu	0.06					25		25	50									50	50	50					⑩
Fe	0.3	50	50	50		50	50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Pb	0.05								10				50		50	50		50	50		25	⑩		50	50
Mn	0.05	50	50	50		50	50		50	50		50	50		50	50		50	50	50	50	50		50	50
Hg (µg/l)	0.05	㊿	㊿				50	50	50	50		50	50		50	50		50	50	50	50	50		50	50
Ni	0.05																								
Zn	0.205								25									50	50	⑩	⑩	50		㉕	
B	1.00	㊿	㊿																						

TABLE F - 11
Water Quality[1] and Consumption Impacts[2] -- 100% Loading Assignment Scenario 7 :

Parameter mg/1	36	38	37	25	23	54	41	10	8	6	3	5	7	17	19	64	15	16	70	69	67	71	66	11-14 (3)
Water Consumption	M	M	M	L	L	M	M	H	M	M	L	L	H	M	M	M	M	H	M	M	M	M	M	M
TDS 500	10	⑩		/		⑩	㊿	㊿		/			/		㊿	/						/		
TSS 50				/		50	㉕	50	50	/		25	/	50	50	/	50	50		⑩		/		50
SO_4 250		⑩		/						/			/			/		㊿				/		
NH_3 1.1				/				㊿		/			/			/		㊿	㉕			/		
As 0.05				/				㉕		/			/			/						/		
Ba 1.0				/						/			/			/						/		
Cd 0.01				/		⑩	⑩	㊿		/	50		/		㊿	/	㉕	50				/	⑩	
Cl 250				/						/			/			/						/		
Cr 0.01	㊿	㊿		/		㊿		50	50	/		50	/	50	50	/	50	50	50	50	50	/	50	50
P 0.05	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Se 0.01				/				㊿		/			/	10	㉕	/	㊿	㊿	㊿	㉕	㊿	/	⑩	
Ag 0.005				/				㉕		/	50	50	/			/	㊿					/		50
Cu 0.06				/	㊿		㉕	50		/			/			/	50	50	50			/		㊿
Fe 0.3	50	50	50	/	50	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Pb 0.05				/				㊿		/		50	/	50	50	/	50	50	⑩	10	⑩	/	50	50
Mn 0.05	50	50	50	/	50	50	㊿	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Hg (µg/1) 0.05	㊿	㊿		/	㊿	50	50	50	50	/	50	50	/	50	50	/	50	50	50	50	50	/	50	50
Ni 0.05				/						/			/			/						/		
Zn 0.205				/				㊿		/			/			/	50		⑩	⑩	50	/	㉕	
B 1.00	㊿	㊿		/	㊿					/			/			/						/		